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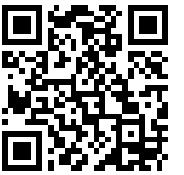

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"THE BEST IS THE ENEMY OF THE GOOD."

SOME THOUGHTS ON FORTIFICATION AND OTHER CONSTRUCTION WORK.

By MAJOR-GENERAL SIR GEORGE K. SCOTT-MONCRIEFF, K.C.B., K.C.M.G., C.I.E.

IT was recently announced in the newspapers, in a not very important paragraph, that the French were dismantling fortifications at Bayonne and at some of the detached works round Paris, that the former, built in the reign of Louis XIV., required dynamite to demolish the work, whereas the latter, dating from the days of Louis-Philippe, only required pick and crowbar. The inference was that the earlier engineers had done better, because more durable, work, and that the latter was the product of a decadent age, a period of compromise and outward show.

This started a train of thought in my mind, pondering the old French proverb, "Le mieux est l'ennemi du bien," and I venture to give to the readers of the *R.E. Journal* the result of my cogitations for what they are worth.

Bayonne was one of the best examples of Vauban's genius, and as it is situated on the southern frontier of France, and therefore not on the most important front, it is unlikely that thoroughness in constructing the works would be applied there if it were not also, to at least as great an extent, applied in Flanders and along the western frontier. Hence it is reasonable to assume that in the many other fortresses which the great French engineer built, there would be an uncompromising solidity as at Bayonne. Indeed, as far as one can judge from casual observation at the present day, the revetments of Lille, as solid and sound as ever, might be taken as samples of the perfection of brickwork and masonry. The amount of such masonry must have been colossal. If we take any reasonable length of the perimeter—say 100 yards, and think what a lot of revetments, passages, ramps, magazines, etc., were required in the bastions and their retrenchments, ravelins, covered ways, tenailles and all the other refinements of the science of fortification as then understood, it is evident that to attain "the best" (and apparently that was what was aimed at) there must have been enormous expense. And yet, no one knew better than Vauban himself that all this perfection of construction could not really render the fortress impregnable. Even

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Lille, his masterpiece, yielded to Marlborough in 1708, in four months, a heroic resistance, it is true, but with an inevitable end. Did the perfection of the work delay that end by a single day? or could the end in view not have been attained by less expense?

These are questions difficult to answer, and the only reply—and that a very unsatisfactory one—is, that at all events the strength of the fortress did not damage the French cause, beyond the relatively severe drain that it involved on the national purse, which in the days of the "Grand Monarque" was being sadly pinched. The presence of the fortress admittedly hampered the movements of the Allies in 1708, though it is at least possible that this end might have been accomplished with less costly means. "The good" in this case was at least not injured by "the best," though it is conceivable that the fortress might have swallowed up, as Metz did in 1870, so large a proportion of the fighting strength as to reduce the power against the enemy. In the case of Metz "the best" was assuredly the enemy of "the good," in this particular respect.

As regards the works round Paris, which now are being demolished with comparative ease, the resistance which they offered to the German attack in 1870 lasted as long as that of Lille to Marlborough. The end came, not from any want of solidity in the works, but from the famine blockade applied to the great city, a blockade which, as we know, was subsequently partially applied in the Great War to Germany as a whole, and declared by the Germans to be inhuman and barbarous.

To attribute the extreme solidity in execution, as well as elaboration of plan, to Vauban may, quite possibly, be mistaken. For he was not only a great soldier and engineer, but, as recent French research has shown, a wise statesman and administrator, and not the least likely to be led away to extremes of expense when a less costly plan would suffice. There were in his day, in France, many great soldiers who would not necessarily place too great a value upon fortresses. Turenne, Condé, Luxembourg were men who had learnt sufficiently well the lessons of the great master, Gustavus, to know that a mobile army must not be tied by its fortresses, though it may find them valuable pivots of manœuvre. But the general tendency of the day was to exaggerate their value, and to regard them as though they were in themselves offensive weapons, and it is at least possible that the weight of mediocre opinion in the war councils of Versailles insisted upon perfection of design and execution, regardless of cost. Thus it may be that Vauban, who no doubt had to submit his plans to the King and had to show in them the highest technical skill in design, was ordered to specify a greater amount of perfection in execution than he would have personally considered necessary. Whether he did so or not, it is certain that subsequent opinion gives him the credit for both design and execution, as indeed is the case

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with every engineer who builds a fortified work, whether he really approves of its details or not.

In our own country, after the Crimean War, there was a very justifiable apprehension that our principal naval bases were dangerously exposed to hostile attack. The recent experience of Sevastopol, situated far away from allied shores, yet attacked by land and sea, with a moderate amount of success, seems to have led to the conclusion that the same operations might be repeated on a larger scale on the shores of the English Channel. The committee that considered the matter was composed of eminent sea-captains as well as soldiers of all arms, and their report no doubt reflected the mature military judgment of the time. Yet they do not seem to have recognized the fact that a landing of hostile forces, followed by a deliberate siege, such as took place in the Crimea, *involves command of the sea*, such as the Allies had in 1854–56, and that the command of the sea to Great Britain is absolutely vital. If that supremacy at sea is lost to this country, there is no use talking about land defences—the less is contained in the greater. Hence the design of a British naval fortress must be governed by resistance to craft coming over the sea, and attacking from the sea; in other words, all effort must be concentrated on the sea fronts, and for a power having naval supremacy that is all that is needed. It is obvious that the *complete* design of such a fortress would differ in the case of an island power with the command of the sea, from that of a continental power liable to attack both from land and sea (*e.g.*, Russia at Port Arthur). "The best" that is the complete theoretical fortification of such a fortress includes, no doubt, complete land as well as sea defences, but it is "the enemy of the good," because it is far beyond what is necessary, is *pro tanto* a waste of public money, and requires, for its complete armament and garrison, guns and men that are much more useful elsewhere. The programme of defences which was begun under Lord Palmerston's auspices in 1860 was a huge and costly task, but it need not have been so large or so expensive had it been recognized from the first that *permanent* land defences might well be omitted, and also that celerity of execution was as essential as solidity, for defensive works, like battleships, rapidly become obsolescent. The works were hardly complete when the Franco-German War came on in 1870.

As an instance take the largest, at that time, of our naval fortresses, Portsmouth. The approaches by the Solent and Spithead were, rightly, guarded by many powerful works, by Hurst Castle, and the Isle of Wight forts on the West, and by other I.W. forts and the Spithead forts (each of which cost half a million) to the east, besides many inner batteries covering the nearer anchorages. But there was also a long line of land detached works guarding the Gosport side on the west, and the long ridge of Portsdown to the north, excellent

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designs and solid construction, but only of possible use in the event of what was really an unthinkable situation, *viz.* : the entire loss of the sea by this country, *i.e.*, utter national ruin. The landing of troops, siege trains, ammunition, etc., to deal with such works would have to be on a scale exceeding that of the Allies in the Crimea, and without the assured command of the sea it would be impossible. It is true that in the temporary absence of the fleet a raid might conceivably be made, landing a considerable force, with field artillery ; but to deal with such a possibility it was merely necessary to arrange for field defences, and to have sufficient mobile armament and mobile troops allotted to the fortress. The land forts, therefore, though " the best," were unquestionably " the enemy of the good," and the blame for this must be shared by the statesmen and the admirals as well as by the staff of the Army and their technical experts, though the latter no doubt are generally blamed.

Although some other naval bases were defended in this unnecessarily complete manner (*e.g.*, Plymouth and Chatham) it was not universal. At Gravesend, for instance, the defence of the Thames against hostile attack—a matter of great importance, considering the value of the commerce in London, a point fully appreciated by our enemies lately—was entirely on the water. Three powerful forts guarded a bend of the river some three miles below Gravesend, and in conjunction with them there were two belts of submarine mines. Provision against a raid, and possible taking of the forts in reverse, was made, by having a careful scheme of field-works planned and assigned for execution to a local volunteer Corps. This was one of the forerunners of the valuable Defence Schemes elaborated for every coast defence work prior to the late war, and which worked so well in practice.

The actual design of coast batteries at that time seems to have been based on that of a battleship of the period, *i.e.*, guns firing through port-holes protected vertically by steel armoury and massive granite piers, and by very solid concrete roofs above. I am not aware that this class of fort was ever tested by the experience of war, but (apart from the great cost of construction) it had the drawback of limits of traversing angle and of elevation for the guns, though it gave good security to the gun and detachment. There was no attempt at camouflage, except in the case of the Spithead forts which were painted in black and white check, which may have rendered them less visible than they otherwise would have been.

The most colossal of all the works carried out in that era, and, to my mind, by far the most conspicuous example of " the best," as opposed to " the good," is the Verne Citadel at Portland. The masonry here is of the most solid character, the ditches are stupendous, lined with cyclopean blocks of Portland stone, like the most massive of the Pyramids. Inside the citadel, where there are

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casemated barracks of similar massive character, even the humblest building is monumental, and any subsequent altering to bring them into line with modern sanitary ideas becomes a herculean task. While we do not forget that the Portland stone quarries are on the spot, and that convict labour was cheap, we may well enquire whether the purpose of the work, *i.e.*, to refuse the occupation of the summit of the peninsula to an enemy and prevent him commanding the waters of the harbour below, could not have been achieved with much less labour. It seems very much like using a steam hammer to crack a nut, when nut-crackers would do the work equally well, and probably better.

Towards the close of the nineteenth century our coast batteries went to the other extreme of protection from land, and of open working. The guns firing *en barbette* had no restriction of elevation and traversing, while the only protection to the batteries from land assault was a steel fence. This latter was frequently proved at manœuvres to be a surmountable obstacle, and consequently some attempt has been made of late years to enclose our coast batteries in works admitting of infantry defence against a landing raid. In the period before the Great War, little attempt was made to camouflage the batteries, but in the only case where it *was* attempted the Germans, curiously enough, attacked (it was at Hartlepool) and completely failed to damage the battery. The guns of the latter, in their turn, did useful work in returning the fire of the attacking battle-cruiser, the range being only some 2,000 yards. This was the only case where our coast batteries were actually engaged with the enemy.

On the N.W. Frontier of India there used to be an absurd rule that works which were intended to be held by regular troops, though designed locally, had to be examined and approved at Army Headquarters (the cost being borne by Army funds), but if the defences were to be manned and occupied by locally raised forces, such as frontier militia or border police, the cost was defrayed from local civil funds and the designs were approved by the Chief Commissioner of the Province and his engineer adviser. Thus (in my time, at all events) the works in the Khyber, Malakand and Kurram were of the former category and those in the Tochi, Gomal and Waziri country generally belonged to the latter. In the latter case, as funds were generally somewhat restricted, the result generally was to try and cut down the cost so as to achieve " the good " without necessarily having " the best," and the work was, relatively speaking, quickly done. One sometimes wonders what the tribesman of the frontier thinks of it all, and whether it puzzles him that in the Mahsud country there is rough masonry and rougher timber, while in the Khyber there is stone-walling of the best and steel loopholes and machicoulis. (I am speaking of 18–20 years ago, and doubtless meantime many

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alterations have taken place.) There has been a lot of fighting of late years in those parts and I often wonder whether the works in the Tochi and Waziristan have stood the test of war; whether, in fact, they were *good* though not *the best.*

When I first went, as C.R.E. Punjab Frontier District, to visit the Malakand, in the days before the good old "Piffers" were done away with, I came across a superior person there who said that he supposed the works there were a specimen of the best fortification that could be devised for the place, that it seemed to him unnecessarily elaborate and that it was a pity that the R.E.'s could not exercise a little common sense in avoiding the best when the good was sufficient. Now he would have been quite right if, instead of being at the Malakand, we had foregathered at, say, Miranshah or Wana (only these places are too unhealthy for casual visitors). But as it turned out, the works he criticized had run the gauntlet of all the military hierarchy, up to the very top of the tree, at Simla. And, although I was quite of his opinion as to the elaborate nature of the works, I knew it was certainly not the R.E. locally who had so devised them, though they had built them according to orders. Moreover, I felt pretty sure that, if another tribal rising should occur, we should be asked for more. And this actually happened a few months later, for there was a scare and the political officer and the O.C. troops both seem to have "got the wind up" badly. The latter ordered the local R.E. officer—a junior subaltern—to carry out an extension to the permanent works, which would have rendered the place more complicated, and really less defensible, than ever. The R.E. officer wired to the headquarters of the Force for instructions and got back a most peremptory refusal. The O.C. Troops ought, of course, to have sought the sanction of the G.O.C. before giving the order, and the G.O.C. was naturally very irate.

The principle of balancing "the good" and "the best" applies, of course, to all engineering works. When I was a subaltern in the 'eighties I went with two brother officers for a week's shooting to Karnal, halfway between Umballa and Delhi, and at one time a most important military cantonment. About the year 1842 it was found that the place had been so unhealthy for several years that it would be better to abandon the site and start a new cantonment at Umballa, using the old materials as much as possible. So the place was dismantled, and the new cantonment was built by Captain, afterwards Field-Marshal, Lord Napier. When I visited the spot, the site of the cantonment was covered with scrub jungle, full of game (we had excellent sport), and the only signs of former occupation were three huge cemeteries, full of crumbling monuments, and a few derelict buildings, not worth removing. Among these were a series of barracks for a British cavalry regiment, solid brick walls and arched brick roofs, and as I looked at them I understood why the cemeteries

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were so large. The brickwork was excellent, the arches were perfect, nothing could be better technically; but life inside those barracks must have been too ghastly for words and, in the hot weather, the interior must have been like a brick kiln. One can only suppose that the original builders did not adopt cooler, if less permanent, materials on the ground that, with permanent construction there would be less expenditure on repairs. This is a bogey which has often stood in the way of real progress, an obsession which both in this country and in India, in civil life as well as in military, has had a baneful influence. The most perfect and permanent barracks I ever saw (from a purely technical point of view) were those built at Lucknow in the 'eighties. The design was rigidly that of the type plans sanctioned at Army Headquarters; the walls were of the best brickwork, the floors and verandah posts of the best cut stone, the roof timber and joinery of the best and most durable wood, and of the best workmanship. Everything was of the best; it was also very costly and, I should imagine, utterly and absolutely uncomfortable. Somebody described it as like living at the bottom of a narrow street. It was all of "the best," but it was not "good."

In like manner, about the same period, a barrack was built in Glasgow, three stories high, of the most solid stone masonry, and other permanent materials. Externally the buildings are gaunt and cheerless, inside they are dreary, comfortless and repellent. There are at the same place married soldiers' quarters of the same general description, and, when recently it was purposed to try and introduce some amenities of life to these comfortless dwellings, the expense of alteration was enormous, because of the difficulty of dealing with walls and floors of such uncompromising solidity. The Royal Barracks in Dublin, which are the oldest in the United Kingdom, were in their day (early-eighteenth century) the finest in Europe, but they have been the subject, in the late-nineteenth century, of innumerable sanitary commissions, and they are still, though solid and substantial, a very difficult sanitary problem. So also are many barracks built in such county towns as York, Ipswich, Exeter, Newcastle, etc., during the regime of awful administrative scandal, from 1792 to 1810, described by Sir Charles Watson in the third volume of the *History of the Corps* (pp. 142–147). The scandal apparently was hushed up, but the barracks, solidly built, still attest the iniquity of the period and are in use—the despair of the engineering reformer. It would be a sound policy to demolish them, but no Secretary of State would allow it as long as they provide accommodation of some sort.

In civil life, especially in connection with hospitals, we see just the same thing. Hospitals that are to-day considered the *dernier cri*, are in a few years anathema to the medical profession, and too often they are built not so much with the view of being suitable for healing

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the sick as for giving an evidence of the architect's artistic skill. A few years before the war a hospital was opened in a northern city which cost £1,000 a bed. Conceivably it was necessary to have a building which was of monumental dignity and therefore it is reasonable to admit that some external treatment was desirable (a principle, however, which has been forgotten in London where a very ugly barrack is in close proximity to a royal palace). But during the war many hospitals were built, some of them of quite pleasing exterior, and in keeping with their charming surroundings, which cost only about £80 a bed, and where the sick were quite as comfortable, and the medical authorities and nurses quite as well able to do their work, as in the palaces which cost ten times as much. Moreover, the former could easily be altered, whereas the others are, and always will be, difficult to improve.

This question of temporary, but good, work was referred to by the present President of the Institution of Civil Engineers in his inaugural address this season, where he spoke of the policy of building railway bridges in Lancashire, during the early years of railway enterprise, of timber arches, replacing these some thirty years later, when weights and speed of locomotives had increased, by steel girders. This was an instance of " the good " being adopted from the first, and not a short-sighted striving after " the best."

Of course, where there is uncertainty as to weight or forces, or where there is certainty that any unsoundness may mean ruin, the engineer must from the first aim at the best. Reservoir walls, sea protection, magazines and many other such cases, will at once occur to one's mind. But where there is the prospect of altered conditions it is better to secure " the good " by the simplest means compatible with efficiency, and leave it to one's successors to alter one's work later, to achieve the " best." This is the policy underlying the light construction principle in military buildings which has been adopted of late years and which, although it has saved the country enormous sums in prime cost, has not entailed large expenditure in maintenance.

One has also to bear in mind to some extent the local conditions of works, the amenities of a countryside, or the conditions of climate. Some years ago, travelling up the Solent on a lovely summer afternoon, I saw what appeared to be a blot in the landscape on the fair scenery of the Isle of Wight. Turning my glass on to it I saw it was a row of recently-built married soldiers' quarters near Golden Hill Fort, of the regular standard plan, hideous and hopelessly at discord with all the surrounding scenery. There are similar rows of the same ugly buildings in the pine woods at Bordon and Blackdown. They are not cheap, they are not homelike or comfortable, but they are (as far as technicalities of construction are concerned) " the best." Royal visitors comment on their atrocious incongruity, and a

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Parliamentary commission that visited Aldershot during the war stigmatized them as " more like prisons than houses," but it would be difficult to pick holes in the construction.

Let us hope that at least these and other similar atrocities will serve as a warning to future generations of R.E. officers, to strive after " the good " rather than " the best," where the requirements are not final and where other factors besides engineering construction have to be considered.

(In connection with the invasion of these islands, those who are interested in the subject are referred to an article by Rear-Admiral Sir S. Eardley Wilmot in *The Nineteenth Century and After* for December, 1921.)

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A TRACTOR RAFT.

By CAPT. C. F. STOEHR, R.E.

ABOUT the end of February, 1918, at Felujah on the Euphrates, the writer was given two "C" class mahelas, or Arab boats, with a capacity of 23 and 24 tons, ten 9-in. by 4-in. R.S. joists 32 ft. long, and planks and ends 2 in. and 3 in. thick as required, and was ordered to make a raft to carry 15-ton tractors across the river, and to work day and

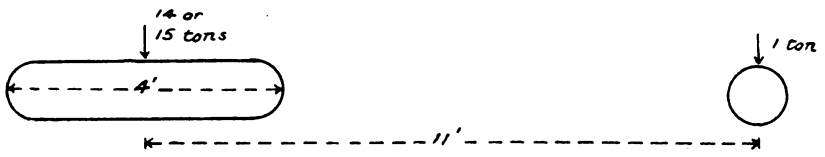

FIG. 1.

night at it. The load consists normally of 14 tons on the 4 ft.-long tractor wheel, and 1 ton on the round front wheel 11 ft. in front, but this front wheel is sometimes lifted, so that for purposes of calculation the load was assumed to be a concentrated one of 15 tons. As the load on the front wheel is small and the whole tractor is shorter than half the length of the joists, no further account need be taken of the front wheel.

It is clear that there will be no difficulty once the tractor is in the centre of the raft, but it is necessary to consider what happens while it is getting there.

The first idea was to put both boats close together and all ten joists across both boats (*Fig.* 2). Since each boat was 11 ft. wide

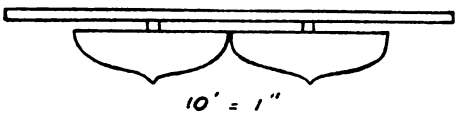

FIG. 2.

the ends of the joists would project only 5 ft. beyond the side of the boat. The small depth of water close to the shore caused a greater projection to be required, and there appeared to be no suitable means for making a gangway, or, if made, for temporarily joining it to the ends of the raft platform.

The next idea was to put the boats about 3 ft. apart (*Fig.* 3) with half the joists on each boat, the centres resting on the saddle and

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the ends lashed to the saddle of the other boat. This would give 10 ft. projection beyond the side of the boat, which was sufficient.

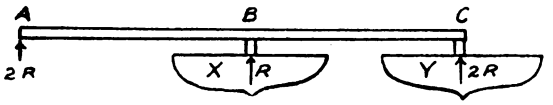

FIG. 3—*Showing one set of R.S.J.*

Assume first that before the tractor comes on to the raft the ends of the joists are just resting on the shore transom. As the weight moves from A to B, the whole raft must pivot about A, boat Y therefore sinks twice as much as X, and therefore takes about twice the load that X is taking.

When W reaches B then, if R is the reaction of X, 2R must be the reaction of Y, and, since AB = BC, reaction at A equals reaction of Y = 2R.

Hence $W=2R+R+2R=5R$ and $R=\frac{W}{5}$

The effect, therefore, is that of $\frac{4}{5}$ W, or 12 tons, in the centre of five 9-in. by 4-in. R.S.J. with a span of 30 ft. (allowing for width of saddle and overlap at A). This is too big a load; also both boats will tilt, and some different arrangement is required to get the tractor off at the other side unless the raft is deliberately tilted by putting the C.G. of the tractor over X, when X would be carrying 15 tons + 5 tons superstructure, which, with the boat tilted, is much too near the limit.

Now consider the end A as being unsupported by the shore transom. As the weight comes on, A sinks, X acts as the fulcrum of the lever AC and sinks, and Y acts as a counterweight, and is raised. Obviously the end A cannot be allowed to sink indefinitely, and this position alone offers no solution.

The idea, however, of combining these two positions by allowing the end A to sink a certain amount, during which time all the weight would come on X, and then supporting A, so that of the remaining weight twice as much would come on Y as on X, suggested itself as containing the germ of a solution. It would, however, be difficult, if not impossible, to calculate the depth to which A should be allowed to sink in order to take a given weight, but a further idea suggested itself, *viz.*, to pivot the centres of each set of joists on its own saddle (*Fig.* 4), leaving the ends on the saddle of the other boat free to rise. This has the following advantages:—

(*a*) Exact calculations are possible.

(*b*) Tilting is almost entirely eliminated.

(*c*) All cantilever stresses, and dependence on lashings holding down the ends of the joists are eliminated.

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The solution was now achieved (*Fig.* 4) and it only remained to get out the calculations and devise practical details.

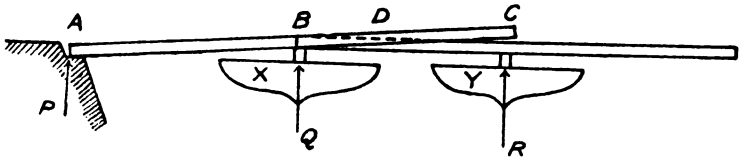

FIG. 4.

*Calculations.**—As the weight rolls on from A to B, B is depressed until the end C comes down on the saddle and boat Y begins to take the weight. The load continues on until it reaches B.

Now when the load is halfway between A and B, the bending moment is $\frac{WL}{4}$. (L=AB). When the load is at B, the effective length of the beam is AC, *i.e.*, 2AB. To ensure that the BM shall not exceed $\frac{WL}{4}$, the effective weight at B must not exceed $\frac{W}{2}$ when the load is at B. Therefore, in this position, Q, the reaction at B, must be at least $\frac{W}{2}$, and, since AB=BC :—

$$P \text{ (reaction at A)} = R \text{ (reaction at C)} = \frac{W}{4}.$$

Now, if d=depression of one boat under the full load of the tractor, the depression of B must be at least $\frac{d}{2}$ to produce a reaction of $\frac{W}{2}$ (this is only approximate, except with vertical-sided boats, but is quite near enough). The depression of C will be $\frac{d}{4}$, and since ABC is a straight line, the shore transom must be $\frac{3}{4}d$ below the saddle of the unloaded raft.

Since d can be found by experiment or calculation, we know exactly the level at which to place the shore transom.

Various Positions of Load.—Y will begin to take the load when B is depressed $\frac{1}{2}\times\frac{3}{4}d$, or $\frac{3}{8}d$, *i.e.*, when $Q=\frac{3}{8}W$; and since R=0, $P=\frac{5}{8}W$. This will occur when the load is $\frac{3}{8}$ AB, or about 6 ft. from A.

From this point Y takes twice as much of the extra load until the point is reached when P=0. At this point :—

$$Q=\tfrac{3}{8}W+\tfrac{1}{3}\times\tfrac{5}{8}W=1\tfrac{7}{12}W$$
$$R=\tfrac{2}{3}\times\tfrac{5}{8}W=\tfrac{5}{12}W$$

* These calculations were worked out by Bt. Lt.-Col. J. F. Turner, D.S.O., R.E.

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This is the highest figure that Q can reach, for as the load rolls on, Q diminishes and R increases.

If the load is at D when Q is a maximum, then

$$W \times BD = \tfrac{5}{12} W \times BC$$
$$\therefore \quad BD = \tfrac{5}{12} \times 16 = 6\tfrac{2}{3} \text{ ft.}$$

After the load passes D, the end A rises clear of the shore transom, so that there is no difficulty about shoving off, or bringing the raft in for disembarkation.

It may be noted that, if the joists are extra strong and the loading capacity of the boats small, then by making the level of the shore transom only $\frac{d}{2}$ below the saddle level, the load on either boat will never exceed $\frac{W}{2}$. Nothing is gained by making the difference of level more than $\frac{3}{4}\,d$.

Verification.—All movements, both for tractor coming on and going off, corresponded exactly to calculations. There was practically no tilting, and though the superstructure weighed 5 tons per boat, there was always a freeboard of 13 to 15 inches.

Practical Details.

1. *Strutting of Saddles.*—The saddles had both vertical and side strutting so that the load was well spread out, and the saddle was at such a height that 1½-in. planks could be nailed from gunwale to gunwale under the saddle, so as to give extra cross-bracing.

2. *Bracing of Raft.*—The boats were kept apart by distance pieces and then well braced together with thin wire rope.

3. *Balance of R.S. Joists.*—The centres of the joists were put on on the outer edges of the saddles so as to make the see-saw as easy as possible, and were held in position by L-shaped spikes driven into the corner of the saddle. The outer ends were wired to a wooden cross-piece clear of their bearing on the shore transom, and the inner ends each had a lashing, by which they could be quickly tied down to a bar fixed below the saddle of the other boat, or cast loose.

4. *Chessing.*—This consisted of a double layer of 2-in. hardwood planks, which were hardly marked by the movements of the tractor. As the chesses between the saddles have to lift with both sets of joists, their ribands must be fixed to the chesses only, not to the joists. The inner ends of the joists must coincide with or be slightly inside the outer edge of a chess.

5. *Anchoring of Raft.*—The coming on of the tractor tends to push the raft out into the stream, so it must be securely held in position.

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6. *Abutment.*—The height of this must be adjusted to suit any rise or fall in the river.

Passage of Tractor.—A 1½-in. steel cable was laid across the river, lying on the bottom, so that traffic up-stream was not interfered with, and was laid over the bows of the boats behind a bollard a few feet from the bow on the gunwale nearest the bank of departure, so that on pushing off the current helped to carry the raft across, the raft picking up the cable as it went. Half a dozen men on the raft pulled on the cable and the whole passage presented not the slightest difficulty. At Dhibban, where there was a bridge, instead of a cable, men walking across the bridge with one or two ropes to the bows of the raft took it across.

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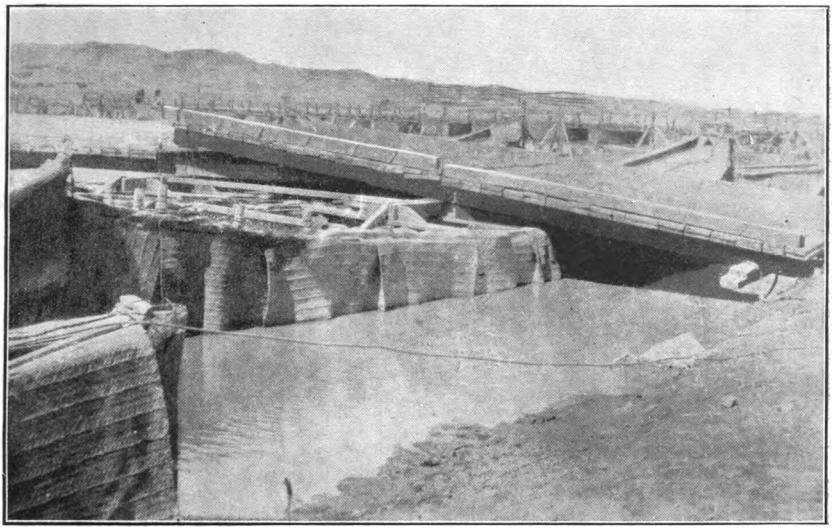
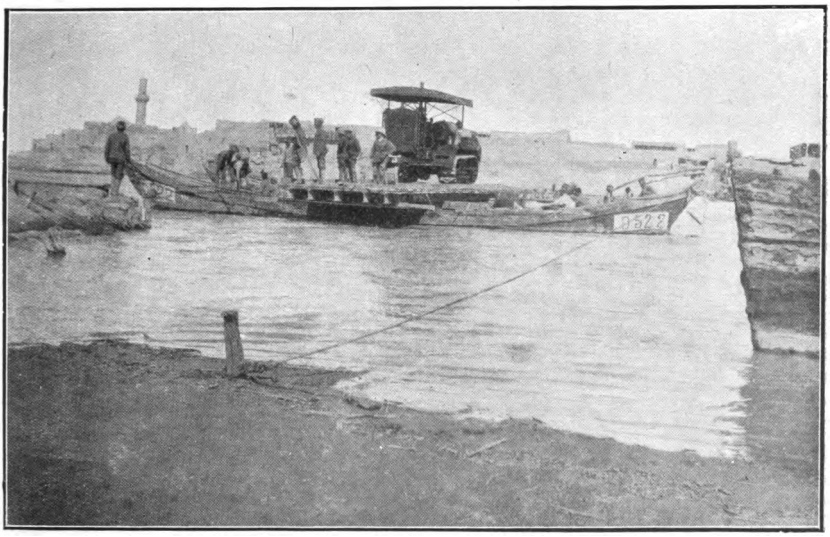
A TRACTOR RAFT.



The Tractor Raft.



Tractor on Raft, Felujah.

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SOME SUGGESTIONS REGARDING THE TRADE ORGANIZATION OF THE ROYAL ENGINEERS. WITH SPECIAL REFERENCE TO ELECTRO-MECHANICAL REQUIREMENTS.

By Bt.-Major H. S. Briggs, o.b.e., a.m.i.mech.e., a.m.i.e.e., R.E.

Existing regulations were framed immediately after a period when the title of "tradesman" was perforce applied to any man with any pretensions to a trade and at a time when recruiting was slack. Groups D and E, in fact (referring to the recent Army Order), comprise men who in civil life are really little better than partially skilled labourers. It is suggested that the trade organization of the Royal Engineers might now be reconsidered.

Labour required for engineer purposes, and particularly for electro-mechanical operations, may be classified as follows :—

(*a*) Directional ; (*b*) highly skilled maintenance or constructive ; (*c*) operative (semi-skilled) ; (*d*) labourers (unskilled).

In illustration of the above grouping the following table is presented for several branches of electro-mechanical engineering activity :—

Grouping.	A Modern Engineering Workshop.	H.M. Navy.	Garage of a big Omnibus Company.	Locomotive Running Shed.	Royal Engineers.
(*a*). Directional	Works Manager & Staff.	Engineer officers.	Works manager. Etc.	Shed Foreman.	Commissioned ranks.
(*b*). Highly Skilled	Foremen. Chargemen. Test bed men. Design men. Tool and jig men.	Engine-room artificers. Electrical artificers.	Foremen. Chargemen. Repair mechanics. Test drivers.	Chargehands. Drivers. Shed Fitters. Boilermakers. Etc.	Mechanists. —
(*c*). Operative ...	Machinemen. Crane drivers Etc.	Mechanicians Torpedo rating. (The latter are trained in searchlights and wiring).	Drivers.	Steam raisers. Storemen. Etc.	Fitter-drivers Electricians. Etc.
(*d*). Labourers ...	Shop labourers.	Stoker ratings.	Cleaners.	Cleaners.	Pioneers.

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THE ONLY OBJECT OF MAINTAINING SOLDIER-MECHANICS IN PEACE IS THEIR EMPLOYMENT AS SUCH IN WAR. If mechanics were required only for the domestic service of the Army in peace time, the work could be more cheaply and efficiently carried out by civilians.

The employment of a soldier-mechanic in war may occur under, generally, one of two conditions :—

(*a*) A war of such dimensions as to necessitate the wide expansion of the technical Services by voluntary or compulsory enlistment of civilian tradesmen, or (*b*) a small campaign in which the technical Services are not expanded by civilian recruitment and are self-supporting.

In case (*a*) the regular soldier-mechanic, by virtue of the military spirit with which he should have been imbued in peacetime, will be most probably selected for promotion, and will be placed in charge of enlisted civilian tradesmen. In case (*b*) the work will be of a general and all-round character and will be carried out by the regular soldier-mechanic himself.

From both the above requirements it is evident that the regular soldier-mechanic should be highly-skilled, and should have indeed superior trade qualifications to those of the enlisted civilian. In this connection it may be noted that the standard of personal craftsmanship in civil life is continually decreasing owing to mass-production and the specialization of industrial operations.

It is suggested that a Royal Engineer trade organization is required, at any rate for electro-mechanical purposes, almost exactly analogous to the Engineer branch of the Navy. Under this system the multiplicity of trades now obtaining of analogous and in some cases identical character, would be abolished and a clear-cut series of trade ratings adopted as subsequently set forth.

The ideal of having in a unit men capable of doing any class of work that can possibly turn up, from paper-hanging to precision-grinding, though a long-cherished tradition, is one impossible of fulfilment under modern conditions. Units must be organized in the main for some definite class of work ; a field company is organized chiefly for work of a " civil " engineering nature ; an E. and M. company is organized for work of a mechanical nature, and so on. The trades comprised in each must, in a general way, suit the character of the work expected of the unit.

For Royal Engineer purposes, trade ratings could profitably be classified into the following main divisions :—(*a*) Constructional (" civil " engineering) ; (*b*) Electro-mechanical ; (*c*) Miscellaneous (survey, etc.).

The first two groups comprise most of the trades required by the Corps. In these notes only the second group (electro-mechanical trades) will be considered, but it is probable that a similar organization could be worked out for the other two. The attainment of a

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high degree of proficiency, both Military and Technical, will always be the aim of the Corps. Technical proficiency in a high degree cannot be acquired and retained by the individual unless he has the opportunity of (*a*) satisfactory training; (*b*) continuous employment on technical work of a varied and progressive nature; and (*c*) an open avenue of advancement for himself.

In order to fulfil the above requirements and thus to provide an expert nucleus—a nucleus which, it is suggested, at present does not exist—the "Establishment for Engineer Services" should be expanded and re-organized in such a way as to put the bulk of the technical electro-mechanical work of the R.E. on their shoulders. They would then be to the R.E. what the engineer branch of the Navy is to the Navy. At the same time, their status should be improved, their personnel should be more closely incorporated in the regimental organization of units, specialist officers should be selected from the same sources as other R.E. officers, and the title "Establishment for Engineer Services" should be dropped.

So far as electro-mechanical work is concerned, the foregoing proposal chiefly involves filling up the gap between the Staff-Sergeant Mechanist and the Sapper with the following ranks:—"Sergeant Mechanist," "Corporal Mechanist," "Lance-Corporal Mechanist."

Under this new system a man, instead of being promoted direct from the ranks to S.S. Mechanist, would have to work his way up through the various grades, gaining experience all the time until he reached the higher supervisory positions. It is probable that under present conditions the only way in which a satisfactory supply of Lance-Corporal Mechanists could be obtained is by training boys in exactly the same way in which the Engine-room Artificers of the Navy are trained. Once the foregoing principles are admitted, the principle of "combined" trades can be introduced. The "combined trades" suggested for electro-mechanical purposes are:—(*a*) fitter and turner; (*b*) boiler and engine smith; (*c*) electrical artificer; (*d*) iron and brass moulder; (*e*) sheet metal worker; (*f*) patternmaker and draughtsman. With five years' training mechanists of combined trades could be expected to possess sufficient qualifications in several of the individual specialist trades set forth in Army Order 362/20.

The following table shows the way in which many trades which are now separate could be grouped under one combined trade:—

(*a*) *Mechanist Fitter and Turner* would have *sufficient* qualifications in the following A.O. 362/20 trades:—Fitter; Fitter (Caterpillar tractor); Fitter (steam tractor and Foden); Fitter Driver; Fitter Driver (internal combustion, lorry and car); Millwright; Toolmaker; Turner; Grinder (precision); Miller and Machinehand; Motor-cycle Fitter; Driver, I.C. (R.E.); Driver, I.C. (lorry and car); Driver, I.C. (Tank Corps); Driver, I.C. (lorry and steam tractor);

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Driver (steam engine); Engine Driver (Marine engineers, etc.); Engine Driver (stationary, steam, etc.).

(*b*) *Mechanist Boiler and Engine Smith*:—Acetylene Welder; Boilermaker; Blacksmith; Riveter.

(*c*) *Mechanist Electrical Artificer*:—Electrician; Fitter, (secondary battery); Instrument-maker (fortress); Lineman; Lineman (power); Cable Jointer; Searchlight Operator; Secondary Battery Attendant; Switchboard and Dynamo Attendant; Wireman (indoor); including three years' training in bench fitting and on lathes and machines.

(*d*) *Mechanist Iron and Brass Moulder*:—Iron Moulder; Brass Moulder; Fettler; Coremaker.

(*e*) *Mechanist Sheetmetal Worker*:—Acetylene Welder; Coppersmith; Plumber; Tinsmith.

(*f*) *Mechanist Patternmaker and Draughtsman*:—Patternmaker and Draughtsman (mechanical), with a general training in works practice.

Since, especially so far as the higher ranks are concerned, electro-mechanical work has to deal chiefly with the operation and maintenance of machinery, it would probably be necessary to limit promotion to and above, say, the rank of Staff-Sergeant Mechanist, to Mechanist Fitter and Turners and Mechanist Electrical Artificers, since these are the two trade groupings most intimately concerned with work in connection with plant. As regards the other trade groupings, whereas possibly some few promotions to the higher ranks might be provided in cases where technical employment could be found in supervisory positions in the larger workshops, etc., it would probably be necessary to arrange some other avenue of advancement. The lure to appointment in the Mechanist ranks would be accelerated promotion.

Mechanists should be appointed in the first place as Lance-Corporal Mechanists, and this and subsequent ranks should be made to correspond as regards pay and promotion, age for age, with the Engine-room Artificer grades in the Navy. The general age for appointment of Lance-Corporal Mechanists should be about 20. This allows of five years' training from the age of 15, corresponding to Naval practice in this respect.

Some Mechanists might be enlisted direct if they were up to the high educational and technical standard contemplated, but the only entry to the Mechanist branch should be as Lance-Corporal Mechanist with an age limit of 23 or 24. Besides the skilled Mechanist ranks, a limited number of semi-skilled ranks are required to dilute the former and also to provide an outlet for the technical advancement of Sappers of mechanical inclinations. Such grades would correspond to the Mechanician ratings in the Navy. For electro-mechanical purposes the following would be sufficient:—Fitter-Driver (Classes 1, 2 and 3); and Electrician (Classes 1, 2 and 3). These would be

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recruited from enlisted men, and it would not be worth training boys for these grades.

Promotion from class to class of Fitter-Driver or Electrician should be dependent on the man's passing successfully a course arranged for each. Thus, Class 2 or 3 would be given after a preliminary three months' training.

He should then join a unit for a period, and if he had enough colour service to complete he would be eligible for a further course for Class I. The present system of granting trade qualifications within the unit should be abolished, for these particular ratings. In order to open up an avenue of advancement for the Fitter-Driver and Electrician grades it would perhaps be desirable to establish a separate system of grades, the candidates for which would be long-service men of mechanical inclinations, who would be trained for two years in one or other trade groupings, as is done in the Navy. On examination of the present limited requirements of the Corps, however, it would probably be found that this series of grades was not required.

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PROFESSIONAL NOTE.

THE TECHNICAL TRAINING OF ENGINEER OFFICERS.

(COMMUNICATED BY THE COMMANDANT, S.M.E.).

AT the present time a certain number of R.E. officers are undergoing a portion of their Engineering Courses at Cambridge instead of the S.M.E. This arrangement is a temporary one designed to expedite the technical training of the officers who were commissioned during the war, but the question of whether it would be desirable to convert it into a permanent system for all officers commissioned in future from the R.M.A. is now under consideration at the War Office. The question of whether or not any change in the present methods of technical training for engineer officers is desirable, and whether the suggestion to give part of that training at a University offers any advantages, is one on which various opinions will no doubt be held. The following memorandum is published with a view to showing what are the principal arguments in favour of the proposal. and drawing criticisms from those who are opposed to the idea.

The series of courses which all officers on first appointment to the Royal Engineers undergo at the School of Military Engineering, with a view to fitting them for their technical duties, amounts to a total period of rather less than two years. Fifty years ago these courses were of the same duration. Yet in this interval the whole range of the science of engineering, both in its civil and its military applications, has been enormously extended; engineering and mechanical sciences generally are now taking a large and increasing part in war and their influence on future military operations is likely to be greater than ever. The standard of engineering knowledge required of engineer officers has therefore greatly increased and it is more than ever necessary that they should be kept abreast of modern developments in engineering theory and practice.

It is evident that the technical training of engineer officers must be continually improving in order to keep pace with the increasing demands that will be made on their knowledge and ability. If we remain satisfied with the standard which was considered good enough before the European war for our military engineers, while the engineering sciences and practice of civil life are advancing by leaps

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and bounds, the inevitable result will be that the engineer services of the army in peace and war will fall off greatly in efficiency, and this will in turn seriously affect the efficiency of the army as a whole.

To improve the technical training of our engineer officers several courses are open to us. One is to extend the period of instruction at the School of Military Engineering so as to be able to include adequate instruction in all branches of engineering practice that it is desirable for engineers to be capable of undertaking. Another is to aim at a much greater degree of specialization among engineer officers, namely, after a moderately short course of instruction in the general duties of military engineers, to allow them to divide into separate branches undergoing specialized and advanced training in one particular subject only, *e.g.*, constructional engineering, mechanical or electrical engineering, field engineering of the "pioneer" level, survey, railway engineering, etc., and to employ them subsequently only in their special branches of work. A third, which has been recommended by Lord Rawlinson's Committee on Engineer Organization, 1919, is to give all engineer officers their training in engineering subjects at a university in such a manner as to ensure their getting the same training as civil engineers. Before discussing these alternatives in detail, it is desirable to consider what are the ends to be aimed at in training engineer officers under the conditions that are likely to prevail in the future.

In past times the career of an engineer officer has generally been remarkable mainly for the variety of the experiences and problems which have presented themselves to him. To a civil engineer the system seems a surprising one which permits of an individual military engineer finding himself at different periods of his career employed on such diverse occupations as design and construction of barrack buildings, command of a field company, lay out and construction of railways or roads in new countries, organization and running of workshops, colonial survey work and perhaps also employment on the staff of the Army. At first sight it may seem that this practice would produce officers who are "Jacks of all trades" but with no more than a limited knowledge of any of them and that such a system would lead to failure in the execution of technical work through want of men with specialized knowledge. It has to be remembered, however, that the problem of the army is very different from that of commercial undertakings.

In the late war the immense engineering requirements could only be met by the enrolment in the Royal Engineers of the greater part of the civil engineering personnel of the country. Most of these engineers were men of more or less specialized training and experience, and many were experts of standing in their particular branch of the subject. It was natural and fitting that they should be employed as far as practicable on their own special subjects. Moreover, the

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vast scale to which the whole of the operations developed made it economical and efficient not only to organize engineer units for specialized work, *e.g.*, field, railway, tunnelling, electrical and mechanical, inland water transport, gas, forestry, etc., etc., but also to avoid interchange of their officer personnel, *i.e.*, to put each man into the line of work for which he was best suited and as far as possible to keep him at it.

This experience has led to the suggestion that the permanent organization of the regular engineers should follow the same system. Some have proposed that there should be separate corps of field engineers, mechanical engineers, constructional engineers, railway engineers, etc., each specially trained for its own special line of work only, and the personnel not interchangeable. Others have suggested that, although the engineer units should be, as they always have been, organized for special classes of engineer work, and that the rank and file personnel should be, as it is now, interchangeable, thus retaining the general organization of a single "Corps," the officer personnel should be trained on specialized lines, *e.g.*, as field engineers, constructional engineers, mechanical engineers, etc., and not be generally interchangeable. In considering such proposals it is necessary to ask whether the functions and the requirements of our very small regular peace army are similar to those of the great national army which was employed in the late war.

Actually, the difference between the two cases is of a similar nature to that between a manufacturing business organized for mass production on a huge scale and another one organized for a very small out-turn of goods of variable type. In the former case great economy is obtained by pushing specialization and standardization to the utmost lengths. Each factory is organized to produce one pattern of article only in endless repetition. In each shop only one operation is undertaken. But in a small business with variable types of work, the shops must be prepared to undertake various tasks; too much specialism will lead to plant and personnel being frequently idle and unproductive.

The functions of our small regular army in war are two-fold:—

(i.) in the case of small wars and expeditions, to carry them out with the peace establishments of the Regular Army expanded to war establishments by the inclusion of the Army Reserve, but with little, if any, further expansion from civil sources.

(ii.) in the case of great wars against highly organized powers to form a nucleus round which the entire national resources in men and material will be organized for the prosecution of the war; to train and instruct the national levies in their duties and to organize and direct them in such a manner that their capacities can be utilized to the fullest extent.

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For both of the above cases to have the engineers of the regular army trained on specialistic lines and non-interchangeable would be uneconomical and inconvenient. It is impossible to forecast which branch of engineering will be most in demand in any future small war and to maintain sufficient personnel to meet all probable requirements in each branch is impracticable. It is essential that, on occasions when a certain class of work becomes temporarily the predominating factor, it should be possible to concentrate on it all the available engineer personnel. In every one of our minor wars this state of affairs has arisen, *e.g.*, in South Africa, 1900–1902, there was a time when the extension and maintenance of the railways became so important that practically all the engineer personnel was turned on to it. At a later stage it was all turned on to building blockhouses. In the European war the same thing was seen. At the outset the biggest demand on the engineers of the regular army was for officers who could raise and train the field companies of the New Armies. Every available officer who could be spared from service with the expeditionary force was allocated to this. On the Western Front the high proportion of casualties made the supply of officers to field units at the front for some time the predominating demand. When this happened it also became necessary to take officers from technical duties on the L. of C. and elsewhere and send them to the front line units, and to replace them in their technical duties by officers who had been with field units, but who were disabled by wounds or otherwise from front line service. Had the Corps of Royal Engineers been organized in water-tight compartments of non-interchangeable specialists, very serious difficulties would have arisen in distributing officers to different classes of work.

For the above reasons it is important that engineer officers should be capable of undertaking any of the principal branches of the work that may fall to a military engineer. This does not preclude a certain amount of specialization. It will always be necessary to have a small percentage of officers who have specialized in mechanical or electrical engineering, survey, railways, etc.; they are required primarily for the purpose of carrying out the duties of the above natures in connection with the wants of the army in peace. Only a comparatively small number, however, are required, and the majority of engineer officers require to have "general service" qualifications. By this is meant that, besides having had a complete military training, experience in regimental duties and knowledge of the characteristics, mode of operation and requirements of the other arms, they should be capable of being employed on any of the ordinary engineering work that may be required in connection with the accommodation of troops, both in peace and war, or with water supply, provision of power and light, road and railway construction and on ordinary geographical survey work. Their military training

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should, of course, include training in field engineering and military bridging and in the co-operation of engineers with the other arms.

Such officers will be capable of carrying out all the engineering works of the improvised type that are necessary in the fighting zone. Of the more permanent and more elaborate works required behind the fighting zone they will be able to design and execute all the normal ones in connection with accommodation for men and horses, hospitals, roads, railway construction, provision of water, light and power, in any campaign of moderate dimensions. When, however, any of these branches of work becomes of such a magnitude or complexity as to make it advisable to obtain the services of specialists from civil life, or preferably from a "Special Reserve," the regular engineer officers will know sufficient of the subject to enable them, if in positions of responsibility (*e.g.*, as Chief Engineers or Directors of Works) to make full use of the services of the specialists, to comprehend their proposals and to realize the extent and the limitations of the assistance they can give the Army; at the same time the engineer officers in junior positions will be capable by their training of working to advantage under the control of the specialists if so required.

The branches of engineering mentioned above do not embrace all the classes of work that may fall to the lot of an engineer officer. Not only are the engineering and technical requirements of the Army continually increasing, but new scientific and technical services are constantly being born. It generally happens that these have to be executed by the engineers until they acquire sufficient importance to warrant a separate organization. Thus the Signal Service, after many years of existence as a branch of the engineers, has only lately been forced into an independent organization. The work of the Royal Air Force was originated and first developed by the Engineers, and mechanical transport similarly began in the Engineers until it was transferred to the Army Service Corps. Gas warfare began in the late war as an Engineer organization. Individual officers are frequently called upon to undertake technical works of most diverse types dealing sometimes with subjects of which they have had no previous experience or training.

The determination of a training which will fit an officer for such varied duties is obviously a matter of considerable difficulty. It is hopeless to try to give him instruction in detail in every type of engineering problem which he may encounter in his subsequent career. In fact, it is evident that the training which will enable an engineer to undertake any kind of work which may come his way cannot be completed by instructional courses alone, but only by a wide practical experience in after life. The wider and more varied this experience can be the greater will be the officer's breadth of outlook and his readiness to accept without dismay, and to solve

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with intelligence, whatever problems may confront him. For this reason it is very undesirable to allow engineer officers to perform the whole, or even the greater part, of their service in one branch of engineer duties. It is particularly necessary that they should obtain experience in the design and execution of engineering works and in the organization and handling of labour. At the same time they should return at intervals to regimental duty with a unit and avail themselves of all opportunities to take part in field manœuvres with other arms.

Since it is not possible, in the short time available for the technical training of the engineer officer, to give him detailed instruction in all the types of engineering problems that he may meet, it is evidently necessary that his training should consist mainly of a thorough grounding in the general theories of the three main branches of engineering, *i.e.*, constructional, mechanical and electrical, to such an extent as will enable him to study intelligently and master without difficulty the details of whatever branch his subsequent career requires him to practice. Specialism of all kinds should be deferred to a later period. This training in theory pre-supposes a knowledge of mathematics, mechanics and physical science of a degree sufficient to make the engineering theories intelligible. At the same time the practical application of theory to the problems which the military engineer may meet should not be neglected. Without some training in such applications, without having been exercised to some extent in working out engineering problems, he may find himself unable to set about even a simple engineering job when called upon to do so. Similarly it is very desirable that he should obtain during his period of training some knowledge of elementary workshop practice, of the processes of filing and shaping, forging, moulding, casting, acetylene-welding, etc., and the use of the usual machine tools, also a similar knowledge of the principal building trades, and of the present day types of steam and internal combustion engines.

This practical teaching can only be given to such an extent as will enable the officer to distinguish good work from bad and to realize the properties and capacities of the various materials and machinery used. It is very desirable that in certain subjects theoretical teaching and practical application should proceed hand-in-hand, but in view of the shortness of the time available care must be maintained to resist the temptation to increase the practical instruction to such an extent as to reduce the theoretical and educational portion of the courses. An engineer who has been well and truly grounded in theory will have little difficulty in making up later on the deficiencies in his practical knowledge; one whose theoretical training has been stunted in order to widen the scope of his knowledge of detail may never get another opportunity of acquiring the theory and may be seriously hampered for want of it.

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The teaching given at a university is mainly of a theoretical character. A man who has been through the Mechanical Science Tripos Course at Cambridge or the engineering course at any of our modern universities has certainly received a very thorough grounding in the theories of the main branches of engineering and also in the mathematical, mechanical and physical sciences which form their foundation. It would no doubt be better if a greater degree of workshop or other practical teaching could be carried out simultaneously with the theoretical teaching than is possible at most of the universities, but this defect, to such an extent as it may be considered to exist, is, in the opinion of many leading practical engineers of the present day a far less serious one than its converse, namely a deficiency in theory caused by too much attention to practice.

It is becoming more and more the practice among the leading engineering firms at the present day to select for appointment to their higher grades young men with a university training rather than with a specialized training. They look on premature specialization as pernicious, and they consider that whatever specialization they want they can teach to their employees, provided they have had a thorough engineering education, much better in their own works than could possibly be acquired in any training school. A similar argument applies to military engineers. The technical details of their engineering work they will pick up better when they come to practice it in after life, than they would if attempt were made to teach them in their training school period, always provided they have acquired a familiarity with the underlying theories, and have been accustomed to the processes of thought required for the solution of engineering problems. These latter qualifications military engineers require in all respects to the same degree as do young men destined for the civil engineering professions, and there can be no doubt that their engineering education must be of the same standard as that of civil engineers.

The engineering education of our Royal Engineer officers consists of a portion of their courses at the Royal Military Academy, Woolwich and the School of Military Engineering, Chatham. Each course is of approximately two years' duration including vacations, etc., but comprises much other education besides that in engineering. At the Royal Academy, cadets receive instruction in mathematics and mechanics, physics and chemistry of the nature suitable as a foundation for the education of an engineer, but the time available for these subjects is limited by the fact that the Academy course must also include military training of the cadets and their preparation for their duties and responsibilities as officers. Nevertheless it is probable that all the cadets destined for the Engineers reach, or could be made to reach, by the time they leave the Academy a standard of scientific education equal to that of the Intermediate examination

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for Honours in engineering at a university or civil engineering college, or that of the Cambridge Mechanical Science Tripos Honours Students at the end of their first year at the university.

The course at the School of Military Engineering includes the remainder of the technical training of the engineer officer in engineering, which is given in the form of courses in constructional and electrical engineering and in machinery and workshops. Here again the time for these subjects is limited by the fact that the S.M.E. course must also include military training, survey, field fortification and military bridging. The three engineering courses occupy about a half of the total course of two years, and, although they include a certain amount of theory, particularly in the construction course, they are in the main of a practical, rather than of a theoretical nature. It cannot be said that these three courses, occupying an aggregate of eleven months, are equivalent to the second and third years of a university training for an honours degree.

The difference lies mainly in the fact that the university course provides considerably more of the theories, particularly of the mathematical theories, underlying engineering practice, whereas the S.M.E. course aims more at familiarizing the officer with the formulæ he can use, the practical technical methods he can employ, and the types of construction and machinery and electrical plant that he is likely to meet in the army. But from what has been said before it will be evident that with the constantly increasing range of work with which the engineer officer may find himself called upon to deal it cannot be possible to familiarize him, during the comparatively short period available for his engineering training, with all, or anything approaching all, of the practical technical methods he may require to use, or of the types of constructional work or of machinery, etc., that he is likely to meet. He will be in a much better position to solve the practical problems that come before him later on if he has had a training in theory equal to that of the university-trained civil engineers, rather than if this type of training has been to a considerable degree neglected in favour of practical technical teaching. Thirty to fifty years ago it was assumed, and probably rightly, that the theoretical and educational training required for the engineer officer was practically all given at the R.M.A. Woolwich and that the S.M.E. course should be mainly practical and technical. As engineering science in all the three main branches developed, endeavours have been made from time to time to include in the S.M.E. course—which has not expanded in total length—instruction in the application of many new engineering developments. The result has been that certain courses have become congested with technical details beyond the power of the average officer to assimilate in the time available. The time has come to abandon the vain endeavour to teach an ever-increasing number of practical applications

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of engineering without a good basis of knowledge of theory to found them on, and to realize that the greater the developments of engineering and the wider range of the applications of it which the military engineer may encounter, the greater is the necessity for ensuring to him this foundation of theory.

It is not suggested that instruction in the practical applications of engineering theory should be neglected. It is essential that the military engineer should not only be exercised in working out engineering problems and receive practical instruction of the nature mentioned above, but also that his courses should include certain examples of the special applications of engineering to military requirements, *e.g.*, principles of design of barracks, hospitals, camps, military roads, water supplies, the chief uses of machinery in the war zone, search-lights, etc., etc. The applications of engineering to the operations of war (as distinct from those to the accommodation, health, comfort, and movement of troops) will of course be taught, as they are now, under the head of fortification and military bridging.

To introduce the increased amount of theoretical training advocated above the possible alternatives are either to alter the nature of a good deal of the course at the S.M.E. and also to lengthen it, or to adopt the suggestion of Lord Rawlinson's Committee that all officers commissioned in the Royal Engineers should undergo their training in engineering subjects at Cambridge University. The latter proposal has certain very great advantages. The value of theoretical teaching depends largely on the efficiency of the teachers. It is more than doubtful whether it will be possible to obtain from the Corps of Royal Engineers a succession of officers—each holding his office for four years at the outside—with the requisite special qualifications. At a great university on the other hand the professional staff are specially selected for their qualifications in the art of teaching and have an experience and an acquaintanceship with the educational standards of the country which few, if any, engineer officers can possess. Moreover, the teaching at a university can be relied on to keep pace fairly closely with the developments of engineering science and practice in the commercial world, whereas it is by no means certain that an institution like the School of Military Engineering will always do so. If the former fails to turn out graduates well qualified to take their place in the engineering world, the fact will not long remain undiscovered, and the number of students seeking entrance at its schools will diminish. In the case of a military institution, it may be a long time before the inadequacy of the tuition is recognized, and the effects may be most injurious to the country's vital interests. When the necessity is recognized for an improvement in the system of training in order to keep pace with outside developments it is nearly always financial considerations which prevent its realization. A university obtains

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its funds from numerous sources, such as the fees of its students, ancient endowments, gifts and donations from the wealthy and benevolent of the present day, and in some cases from firms and commercial corporations belonging to the professions which benefit by the researches and studies carried on there.* It is needless to ask which is more likely to be able to overcome financial difficulties, an institution of the above nature or a government military educational establishment which has to struggle for its funds with the Treasury.

The engineer officer who obtains his engineering training at a residential university, such as Cambridge, enjoys the great advantage of mixing in the society of young men of his own age destined for all kinds of civil professions. Many of them are men of intellectual power or originality. Some will in the future make their mark in public life, others in the scientific and learned professions or in the commercial world. To mix with these men by residence in the colleges and to take part in their recreations as well as their studies is bound to have the effect of broadening the mental outlook. The members of any profession which lives and works in a circle of its own are bound to have a tendency to narrowness, and neither the Army as a whole nor the Royal Engineers in particular are any exception to this rule. As matters stand, the Royal Engineer officer undergoes four years of training at Woolwich and Chatham during which, except for his association at the former place with cadets destined for the Artillery, he is quite aloof from the rest of the Army and from men of his own age in civil life. The opportunity for mixing intimately with the latter, learning their point of view and measuring himself by their standards is certain to be of great value to himself and to the Army.

An objection that has been raised to this proposal is that officers who have been to a university for part of their training will deteriorate in military spirit and discipline by having been withdrawn for so long a time from military surroundings and atmosphere. Fears are also sometimes expressed that at the university some of them may run wild, neglect their studies or develop undesirable eccentricities of thought and behaviour. The dangers of any of these things happening can be guarded against without difficulty. All the officers who go to Cambridge will be required to undergo, in addition, courses at the School of Military Engineering in military

* The Natural Science Schools at Cambridge University recently received a donation of £210,000 from certain associated firms in the oil industry for the expansion of the schools in order to encourage research and study on the chemistry of oils. The Engineering Schools have also received considerable donations towards their new building scheme and gifts of up-to-date machinery from manufacturing firms. Their capital expenditure last year from University and various sources amounted to £95,000.

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training, survey, fortification and military bridging and in the practical applications of engineering to military purposes. These courses would last at least a year and a considerable portion must be subsequent to the Cambridge course, thus providing an opportunity for a corrective being applied to any signs of deterioration in military qualities. Moreover, the continuance of the system which exists in the case of the officers who are now at Cambridge, *i.e.*, of putting them under the administrative control of the Commandant, S.M.E., who exercises this control through *liaison* officers resident at the university and watching progress in studies, etc., of the officers, affords a ready means of intervention if any symptoms of the nature referred to above should appear.

It has been asked why this proposal has been raised in regard only to Cambridge University and why advantage should not be taken of the facilities available at some of the other universities, more particularly some of those which specialize mainly in scientific and engineering subjects. The number of officers who, when the post-war Army Establishments are fixed and have been built up, will be required to undergo this training each year will not be great. It will only be such a number as is required to make up the normal wastage. Before the war this was thirty to thirty-six per annum. Even if it is greater than this in the future it is not likely to be much greater. To divide up so small a number in little packets among a number of universities each of which has different rules, systems of education, fees, etc., would give rise to extreme inconveniences of administration, inequalities in the training given and great difficulties in watching the progress and in dealing with the university authorities. Hardly less inconvenient would be any system of sending each year's batch to a different university. Any idea that by sending them all to one university the War Office is showing partiality or failing to distribute its favours equally may be dismissed. The favour is on the other side. The course of study and the conditions of residence in the case of the officers are bound to differ in some respects from those of the ordinary undergraduate. By putting themselves out to receive our officers and thus to exclude civilian students, the university and college authorities at Cambridge have conferred a marked obligation on the Army Administration. It is also of great importance that the university to which the officers go is one with a residential collegiate system such as exists in the old universities only. The opportunities of mixing intimately in the college life is, as has already been said, one of the great advantages claimed for the proposal. To send a batch of budding officers who are being educated at the public expense to an institution where they would have to live in town lodgings and where their actions outside the class-room would be uncontrolled and unobserved would have obvious serious disadvantages.

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It is contended, therefore, that the advantages, which have been described in the foregoing, of a university training in engineering for the future officers of the Royal Engineers, greatly outweigh any possible disadvantages and that they are such as to warrant the acceptance of the principle that such a training is *per se* a desirable thing. Much consideration will have to be given in detail to the conditions under which the university authorities might be disposed to receive them; to the length and scope of the course (which will not be the same in all respects as that which is being undergone by the more senior officers who are there now); to the financial aspects of the proposal and to the changes entailed at the S.M.E. by the reduction and alteration of the junior officers' courses there. None of these questions are touched on in this memorandum which deals only with the broad aspect of the desirability of the proposal.

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LORD KITCHENER.

By LIEUT.-GENERAL SIR HENRY M. LAWSON, K.C.B.

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THE difficulty, if not the impossibility, of arriving in the present at anything like a complete judgment on Lord Kitchener and on his achievements is very well illustrated by Lord Esher's latest production, *The Tragedy of Lord Kitchener*. The main facts of the great career are of course clear, and were well brought out in Sir George Arthur's interesting volumes, but when one tries to go a little deeper and forecast what his final position will be among the world's really great men, the present-day obstacles to doing so at once become patent.

Apart from the fact that we are still too close to recent tremendous happenings, the great difficulty in publishing any well-balanced appreciation of Lord Kitchener lies in the fact that at various stages of his career before, but especially during, the Great War, he crossed swords with many eminent men now living—statesmen, soldiers, politicians, newspaper proprietors, and journalists. There were doubtless two sides to the differences and combatings, but no real conclusion regarding some of the most important of them can be reached without the readiness to pass adverse sentence if necessary on the judgment, foresight, and in some cases the good faith of many living men. Anything else may involve injustice to the dead.

What would be for anyone a distasteful task was well-nigh an impossible one for Lord Esher. As a courtier and a man of affairs in the years preceding the war, Lord Esher was in close touch with many of those referred to, and in some cases was united to them by bonds of friendship and sympathy. Further, Lord Esher, who had had a memorable share in reforming the War Office and inaugurating a General Staff, was also a member of the Committee of Imperial Defence which was responsible for working out that war policy that Lord Kitchener ultimately overturned. For one so placed it was difficult to dispense even-handed justice as regards Lord Kitchener and to give their full weight to criticisms which involved not only his friends but himself. It makes one wish that Lord Esher had preserved silence and had been content to leave his journals to the judgment of the Mr. Lytton Strachey of sixty years hence. The book, however, has been published, and it gives Lord Kitchener much less than his due; it accentuates, moreover, views at present current in certain quarters which seem so mistaken that this article is written in the endeavour to give the reader a truer presentment of certain characteristics of a great public servant.

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As a commencement the writer disagrees with the opinion held by some and given expression to by Lord Esher as to the predominating share which the East had in moulding Lord Kitchener's character. From reading Lord Esher's pages one draws the impression that most of our hero's early life was spent in the desert with Arabs for his companions, and removed from the influence of the civilized world. Palestine, Cyprus, and Egypt may seem a long way off to some of us, but they are by no means removed from Western influences or out of touch with European politics. Lord Kitchener's work in all that involved higher direction lay for the most part with his own countrymen and in an atmosphere less out of the civilized world than India or our outlying dependencies.

It has been said that there is no provincialism so ingrained, so unconscious as that of London, and to a trace of it perhaps we owe the view that Lord Kitchener's sixteen years in Egypt had turned him, if not into a yellow, brown, or black man, at any rate into a confirmed and thorough-going Oriental. What Egypt and the East did for Lord Kitchener was to give him in his early years a field for work where the individual had fuller scope for growth and for achievement than was possible in the more complicated and restricted conditions at home. There seems nothing to lead to the belief that during these years Lord Kitchener neglected wider home and European conditions, or that he acquired qualities and habits that unfitted him for dealing with affairs in this country.

Another point which Lord Esher labours and on which the writer differs with him is that Lord Kitchener reached his zenith in 1898 when he reconquered the Sudan, and that the man who became Secretary of State for War sixteen years later was a feebler and less dominant personality than the victor of the Atbara and of Omdurman. It was only a year ago that the writer was discussing Lord Kitchener with one who knew him as well as, if not better than, anyone now living, who went through the Omdurman campaign with him, and who remained in constant touch with him from then up to the end. The point he made was that Lord Kitchener was a man who was always developing and always imbibing new ideas. Admiring him from the first he remarked how crude in some respects was the victor of Omdurman and how immensely he developed in South Africa, in India and in his later administration in Egypt. Every time he met the great man he seemed to find some new growth in one whose experience and horizon were constantly widening. Lord Kitchener, in his opinion, was always learning, and he never had to learn the same lesson twice.

From the first he developed slowly: as a boy at Woolwich his comrades saw no signs of his future greatness, and some of them laughed at the angularities of his then character, the strong individuality of which was just beginning to show. His intellectual talents judged by standards of books and examinations were not great, and in this respect he was outclassed by most of his Woolwich contemporaries. At Chatham it was much the same, but one at least of his instructors there saw signs of the future greatness.

When in 1881 the writer first met Kitchener, then head of the Survey

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and Registrar of Lands in Cyprus, his reputation as an administrator, a man of character, and one with a future before him had been made. Later on in 1883 the writer was in Egypt when Kitchener joined the Cavalry of the Egyptian Army as its second in command, and in the following year he was told by an English cavalry officer, then one of Kitchener's comrades, that he looked upon their second in command as the most efficient cavalry officer he had ever met. Growth in mind and character developed steadily in circumstances which admitted and favoured it, and carried him in fifteen years to what Lord Esher has termed his zenith—the conquest of Omdurman.

But neither then nor at any later stage was Kitchener quick at intellectual fence or in mental gymnastics, and this fact, coupled with his obvious force of character, has always caused some observers to depreciate his powers of mind, whilst more nimble-witted folk who did not know him well were inclined to think that he came to hasty judgments and did unconsidered things. In reality nothing could be further from the truth. He had to a pre-eminent degree the power of recognizing and summing up the essential factors of a situation, giving to each its due value. His view was always a large one, with a genius for recognizing and holding fast to the important things and of seeing the minor points in their true perspective; in settling details he never forgot the whole of which they formed a part. His eye was ever on the future, which he visualized with astonishing accuracy. Many of his fellow-workers have evidenced the long view he took even in smaller matters. Patience in thought was one of his great qualities, and in a question of primary importance he was generally slow to form a judgment. Above all things a thinker, he considered the problem from every point of view, heard what anyone and everyone had to say about it, and then at length, by what to some seemed intuition or instinct rather than reasoned thought, he arrived at a conclusion that was rarely mistaken.

It was when his mind was made up that his character came to his help. "Mens aequa in arduis" was his, and in no common degree, courage, physical, moral, intellectual. His opinion once formed he carried it through because he had the courage to believe in its correctness, and the fact that sometimes able minds did not agree with him never shook his belief in what his patient reasoning had told him was right. This intellectual courage was perhaps his greatest asset, and, as will be seen later, it was this quality that served him so well at the supreme crisis of his life, in August 1914.

In the translation of decision into action his indomitable will and resolution came to his aid. Once he had made up his mind that some end had to be reached, nothing turned him from his purpose, and with his eye ever fixed on the goal, sometimes a very distant one, unhasting and yet unresting, he worked towards it. Nothing tempted him to deviate.

The difficulties in the way of accomplishment seemed so much less to him than to his agents that he was always asking of them more than they thought they could perform, and, as a result, they generally achieved, not all he asked, but much more than they had ever thought

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feasible. If an obstacle barred the road, he passed round or over it, if possible, but if this proved impracticable and there were no other way, why then the obstacle had to go to enable him to arrive, for arrive he must. No wonder that he sometimes seemed to achieve the impossible.

Space does not allow of following him in detail between 1898 and 1914, but everywhere there was growth in character and judgment, together with unfailing success in execution. There was always, however, an accompaniment of foreboding, and depreciation by those who underrated his intellectual power to grapple with a new situation.

The writer remembers how when Kitchener's first step in South Africa was to "scrap" the then Army system of transport, people said "K. does not know and is just upsetting the English system because it is different from the Egyptian." Results of course proved that Kitchener's conclusion was right and that the critics were wrong.

That the first success of the war, Paardeberg, happened at all was due to his rapid seizing of a fleeting opportunity (not at all in the manner of Darius and his slowly-moving hordes), and to the way in which he urged on our tired troops to catch Cronje within the net.

With due deference to Lord Esher, who talks of Paardeberg having been mismanaged, Kitchener's instinct to attack there was absolutely right, as was borne out in the German Official Account of the war, and whatever mistakes or mischances there were in execution will be pardoned by any soldier who has been over the ground and has visualised the situation with which Kitchener had to deal. His loyalty and nobility of character, his true magnanimity, were evidenced by his actions after Lord Roberts arrived on the scene and disapproved of what seemed to him an unnecessary loss of life. Kitchener never sulked, argued, or showed disappointment, but did whatever lay nearest his hand to do, often in circumstances which would have tried the majority of men. His attitude to Lord Roberts was that of a good son to a good father.

Later on, when, after Lord Roberts had gone home, Lord Kitchener assumed chief command in South Africa, fears were expressed as to his capacity to deal with the military problems before him. "K. does not know," "He is ignorant of the British Army," were phrases on some people's lips. Mistakes were doubtless made, but the matter was adequately summed up by one who said "K. may have made mistakes, but I cannot think of anyone else who would have carried through the task at all."

The view he took of the peace and his share in bringing it about showed how well his mind could size up a situation which called more for the instincts of the statesman than of the soldier. His success in dealing with the Boer leaders and the trust they reposed in him were due to his capacity to see their point of view and to the effect of his great personality. Whilst Lord Milner was out for an unconditional surrender, Kitchener, with longer vision, saw the wisdom of a "peace on the basis of mutual agreement which he believed would serve to form an indissoluble bond." We owe our present united South Africa to the fact that his view prevailed.

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Forebodings were again heard when Lord Kitchener went to India as Commander-in-Chief, sinister auguries that he would be handicapped by his masterful temperament, by hasty judgment and by his lack of Indian experience. He waited a year, however, before he settled on what were necessary changes, but having once made up his mind, he pressed his reforms through, although at one time the effort to give effect to some of them seemed to him to mean his own downfall. As a result he placed the military position in India on a thoroughly efficient and modern basis; whilst still a learner he imbibed new lessons and experience in his own profession, and his wide outlook continued to broaden.

It is a matter of regret that Lord Esher, although the doing so may have poured balm on the wounded spirit of "one of the most justly famous of our Viceroys," should have implied that Lord Kitchener used in connection with his altercation with Lord Curzon "methods which the Israelites inherited from Jacob and the statesmen of the Renaissance from Machiavelli." The writer believes the suggestion to be without foundation, and an onlooker who had the closest knowledge at the time of all the facts assured him years ago that in this painful episode Lord Kitchener behaved with exemplary moderation, patience, and straightforwardness.

(Lord Esher makes the same insinuation in respect to the Vereeniging negotiations, and with, if possible, even less excuse.)

The three years in Egypt which followed Kitchener's Indian Command were marked by no signs of decay. His industry and his vigour were just as great, the reforms he introduced indicated the same shrewdness of perception, and the immense success of his administration was beyond question.

This rapid survey between Omdurman and 1914 has been made because the facts seem so clearly to point to a great development in the sixteen years which had elapsed since the time when, according to Lord Esher, our planet had commenced its descent towards the horizon.

He was of course sixteen years older when he went to the War Office than he was at the battle of Omdurman, and there doubtless had been some physical weakening, but in 1914 there was nothing to suggest—rather the contrary—that Lord Kitchener was then old for his years. Whether the vigour had lessened which inspired the purpose and fixed determination so marked in the re-conqueror of the Sudan will be seen from a consideration of what he did in the early days of August 1914.

For some years before 1914 the principal members of the Cabinet, the Committee of Imperial Defence, the Admiralty, and the War Office had realized that in certain circumstances it might be our duty to engage in war in support of France and Russia against Germany and Austria, and had made their preparations accordingly. In such an eventuality they had promised France to send her an Expeditionary Force of Six Divisions and a Cavalry Division, with the possibility of one or two more Divisions later. The Territorial Force was to take over the Military Defence of the United Kingdom and the Special Reserve was to feed the Expeditionary Force with men; on this basis the business of the War Office in the event of war was limited to keeping

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the force up to strength and perfecting the arrangements for Home Defence.

As the Government and their military advisers saw it, we were to engage in the war, as Lord Esher says, on the plank of limited liability, and they never seem to have realised the colossal risks of doing so or never visualised the possibility of finding that the only chance of bringing such a war to a successful conclusion lay in throwing every ounce of national strength into the struggle. World financiers had stated their belief that for economic reasons no world war could last for more than a few months, and it was known that Germany—although probably for very different reasons—also believed that the struggle would be short and sharp. These views had probably their weight with the Government, whilst their military advisers had never contemplated it as possible, once war was declared, to improvise new military forces in time to affect the results of the struggle.

Neither civilian nor soldier perhaps realized what effects a declaration of war would have on the nation at large, rendering impossible in itself a policy of limited liability.

Be this as it may, we went to war with no army but the Expeditionary Force and with no intention of, or no preparedness even on paper for, developing the military resources of the Kingdom, or bringing the forces of the Dominions into the struggle. It is no answer to say that motives of secrecy or expense were a justification for this unpreparedness, for it would have been perfectly feasible, if our General Staff had arrived at opposite conclusions, to have had, without the expenditure of an additional penny, secret plans for rapid development of our forces once war was declared. But there might have been such schemes in the War Office ready for immediate translation into action, including among other things how best to set about getting the munitions of war, the clothing, blankets, etc., required for the great expansion—in fact, there might have been some such plans drawn out in peace as Lord Kitchener and the War Office Staff had to improvise in August 1914. There was nothing of the kind, and there can be no doubt that no such expansion had been contemplated by the Government or by its military advisers.

The details of the "limited liability" plan had been admirably worked out, and a perfectly equipped and trained Expeditionary Force was the result, and for this the pre-war War Office are entitled to our everlasting thanks. But that the Committee of Imperial Defence and the newly constituted General Staff specially charged with the consideration beforehand of plans and problems of war should have had so little grasp of the larger perils and actualities of the situation is an interesting proof of the fallibility of clever, industrious, and well-meaning men.

Such, in general terms, was the situation which Lord Kitchener found and which caused his first remark on visiting the War Office to be "There is no Army." Then what seems nearest to a miracle in these modern days happened. This pronounced Orientalist, ignorant of Western ways and problems, this worn-out man who, in Lord Esher's opinion, even then realized "that the qualities of mind and character

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which had served him well through life were under entirely new conditions out of place," saw the truth at a glance ; that a life-and-death struggle was before us, that, unless we were to lose, the struggle must be a long one, and that our only hope of successful conclusion lay in abandoning our policy of limited liability on the chance of being able at the eleventh hour to produce in time a new army sufficiently large to count in a European War. In Lord Kitchener's own words to the House of Commons a few days before his death :

Such an idea was contrary to the theories of all European soldiers. Armies, it had always been argued, could be expanded within limits but could not be created in time of war. I felt myself that though there might be some justice in this view, I had to take risks and embark on what may be regarded as a gigantic experiment.

Lord Kitchener formed this opinion and seems to have been alone in it, and that he succeeded in getting our Government at once to alter their policy was a tribute to his power and personality. It is to be remembered too that practically all the best military opinion in this country was against him as regards the practicability of raising the New Armies. One distinguished soldier after another came to him to try to convince him of the futility of the idea. It was Lord Kitchener alone against the military thought of England. Here indeed was a situation to test the courage and the vigour which inspired purpose and fixed determination, qualities which Lord Esher would have us believe he had left behind him in the deserts of the Sudan.

That the views alluded to regarding the raising of the New Armies were held by the Headquarters Staff that went to France in August 1914 is illustrated by the following incident. One of the first steps which Lord Kitchener took towards the forming of the New Armies was to order each battalion of the Expeditionary Force before it left for France to send to its depôt a small cadre of officers and N.C.O.'s to help in the formation of the new units. To one of the meetings of the Staff held before they went to France, the news of this was brought by one of its most brilliant members, who declaimed against it as damaging to the efficiency of the Expeditionary Force and as a proof of Kitchener's ignorance and lack of understanding. And now we are thankful for this ignorance and lack of understanding !

The opinion above expressed was doubtless a genuine one, and it illustrates the view then held by some soldiers that Kitchener was not fitted to grasp the military problem before him.

The following testimony from a " Dugout " artillery officer indicates how conscious Kitchener was of the views opposed to his. In May 1915, on the day of the Cabinet crisis before the first Coalition Government was formed, Kitchener made a hurried visit to inspect some of the newly formed Divisions on Salisbury Plain. It fell to the lot of our informant to command the Artillery of one of the Divisions, and he records the incident as follows :

One of the brigades had gone out for the day and could not be recalled in time, but the other three brigades and the Divisional Ammunition Column paraded for inspection. The batteries were splendidly horsed

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and the men after several months' training on the Plain rode very well, and as they trotted past Kitchener in column of sections presented a fine appearance. The Field Marshal, as pleased as a schoolboy, was delighted and as I stood alongside of him said, " We've done it, we've done it, they said we could make Infantry but could not make Artillery, and yet we have done it all ourselves, we have trained the men, made the guns and the harness, and bought the horses. We've done it ! "

The conclusions which Lord Kitchener put into practice in the early days of August 1914 were arrived at, not by instinct or by a hasty summing-up of a new problem but by a study in the previous years of a situation which he knew would present itself ; by thinking over the facts as they appeared to him, and not as seen through the spectacles of politicians and financiers. Lord Esher himself tells us that, in the days that followed the opening of the battle of Ypres, Kitchener repeated his conviction as to the length of the war's duration.

He pointed out how the prophecies of politicians and soldiers had been falsified. How could it be supposed, he asked, that a nation of 65 millions, highly organized as Germany was, would be beaten to its knees under years of fighting ? Her internal resources, her food supplies, her man-power, had all been worked out and showed margins far beyond those of the North in the American Civil War, and it was certain that before relinquishing the struggle Germany would exhaust every possible supply of material and men.

In a letter to Lord French written on August 27th, 1914, Kitchener writes :

Believe me had I been consulted on military matters during the last three years I would have done everything in my power to prevent the present state of things in which this country finds itself.

There are some who, believing in predestination, hold that all Lord Kitchener's previous life, its successes, its trials, its various incidents, were but a training to enable him at the supreme moment of his life to take the step which saved his country. They even go so far as to believe that a Divine Hand guided Lord Morley when by rejecting Kitchener for the Viceroyalty of India (on other grounds apparently a most unwise proceeding) he left him available for his predestined work.

Let us recollect, moreover, that the insight which grasped the essentials of the situation could not have availed without the confidence which his previous career had inspired in the British people, and neither the insight nor the confidence would have sufficed without the driving power which carried out vast schemes and overrode all difficulties.

It is doubtful if history furnishes a more dramatic incident, or one more fraught with results, than this action of Kitchener's in the early days of the war, and it justifies Lord Haig's words, " Who can doubt that but for this man and his work Germany would have been victorious ? " This, and not the Atbara and Omdurman, was the climax of Kitchener's career, and it was incomparably his greatest achievement.

It would take too long to follow our hero's actions through the war, or to tell how, with his home burdens upon him, he kept his eye on, and evinced extraordinary insight into, the strategy of the war. He

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was the first to divine the direction of the main German advance, and it was he who saw the supreme necessity of our working hand in hand and side by side with the French, causing his famous interview with Lord French on September 1, 1914. His influence was far-reaching and extended to every Allied country. In France his picture was to be found alongside of that of Joffre in almost every cottage, while in Russia his name acted as a talisman to all.

It seems difficult to exaggerate what Lord Kitchener did for his country and its Allies whilst he lived, and the facts justify the statement that so far as individuals on the Allied side are concerned, he must be given the predominating place. This, however, appears to be imperfectly appreciated in England, and explains why we hear so much minor criticism (mostly uninformed and capable of refutation), with a strange ignoring of the services rendered. The absence of a sense of proportion is surprising, and the critics seem in the position of a shipwrecked crew who, when rescued, commence to cavil at the methods adopted for their deliverance before rendering thanks to their saviours.

Take as one instance the criticisms over what may be called the munitions incident. Lord Kitchener from the first took the long and the large view not only in regard to men but also in respect to munitions of war. While other men thought in tens, he acted in thousands. In the very early days of the war orders were put out for machine guns and ammunition, not based on the requirements of the then tiny Expeditionary Force, but on what would be wanted for the New Armies when they came into being. Provision was an enormously difficult question, but no one who was behind the scenes, or indeed who has read Sir George Arthur's volumes, can doubt that Lord Kitchener realized the difficulties before anyone else, and did all that was humanly possible to obtain at the earliest date what was required.

The writer believes that history will record that the attack which Lord French and the Press made on Lord Kitchener over the ammunition question was absolutely undeserved. We can only surmise how it came about.

There is little doubt that a feeling existed at the time in G.H.Q. in France, due to misconception or to misrepresentation, that Lord Kitchener and the War Office were not sufficiently studying the interest of the Army in France and realizing its difficulties. Never was a feeling more mistaken, and anyone who had experience of the War Office in the autumn of 1914 appreciates that the one aim and desire of Lord Kitchener and his band of workers was to help our troops and their commanders in every way they could. How the opposite belief arose it is difficult to say, but there can be no doubt as to its existence. To some extent perhaps it was due to a certain jealousy of Lord Kitchener and to a distrust as to his capacity to understand and handle modern war. That it was even shared in at one time by Sir William Robertson is shown in an extract from one of his letters quoted by Lord Esher: "I feel remorseful of my brutal bargain; it was never necessary, and was made only because I was misinformed of the man's nature." When to such feelings we add the high mental tension on the battle front, it is not hard to see, when once the idea was suggested that Lord Kitchener

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was responsible for the inevitable shortage of ammunition, how it spread amongst those who talked, and every soldier of experience knows how much "talk" there is among his brethren in the field. Lord Kitchener himself scented intrigue, and was convinced that the clamour for shells and munitions was exaggerated and wantonly factious, and he was admittedly slow to take offence or to impute motives. There were undoubtedly pressmen anxious for a stunt, and so an attack was made with no foundations so far as Lord Kitchener was concerned. His real bigness of character was never more clearly shown than in the way in which he took this wholly unmerited onslaught, and the message which he subsequently sent to Lord French, as related by Lord Esher, is evidence of his real magnanimity and of his characteristic determination never to let personal matters obscure those of larger import. "I am out to fight the Germans and not to fight Sir John French."

A few words may perhaps be added as regards Lord Kitchener and the Cabinet, although it is admitted that the information at present disposal is necessarily incomplete.

It is to be remembered that when Lord Kitchener joined the Cabinet he did so on a non-political basis and solely for the prosecution of the war. Further there is no question that at the outset, and until early in 1915, his word was law in all that concerned military operations. Later on, however, when the imminent dangers that at first beset us were past and members of the Cabinet and people outside it had recovered from early apprehension, a vein of criticism of Lord Kitchener grew in certain quarters both in the Cabinet and outside it.

> Damn with faint praise, assent with civil leer,
> And without sneering, teach the rest to sneer;
> Willing to wound, and yet afraid to strike,
> Just hint a fault, and hesitate dislike.

That Lord Kitchener and some of his colleagues should have had difficulties with one another is capable of comprehension. The War Secretary had not the gift of exposition, and he was chary of divulging his plans; he probably did not take kindly to a flow of verbiage from men trained to talk, anxious to know, and doubtless anxious too to be doing something when perhaps in Lord Kitchener's province there was nothing for them to do. It may be taken too that he was not a willing witness when cross-examined by some of the famous advocates among his colleagues. All this is perfectly likely, especially when it is remembered how different was his previous training and mode of life from theirs. But when Lord Esher talks of Lord Kitchener having destroyed the admiration, the affection, and almost the respect of the statesmen who were his closest colleagues, one begins to wonder.

That there were early intrigues to get rid of Lord Kitchener is hinted at in Lord Esher's pages, and one gathers that those intrigues reached their height when he started on his mission to the Dardanelles, but the actual truth concerning these happenings will never be known until the memoirs of men like Mr. Asquith are given to the world. As things stand at present, it is well to remember that some at least of those

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concerned cannot be looked upon as wholly disinterested: some had crossed swords with Kitchener and failed, others had old scores to settle, whilst possibly others had axes of their own to grind. In any case far more evidence than Lord Esher has produced seems required before delivering judgment against Lord Kitchener. In the absence of more authoritative testimony the writer prefers to hold to what is known as against the unexamined impressions of men swayed by many motives, as against in fact what may be termed Cabinet and society gossip.

The unsuitability of a Cabinet of twenty-three members to discuss questions of strategy and military operations is patent, and the discovery of this fact led to the ultimate formation of a War Council. The most that can be said against Lord Kitchener as a Cabinet Minister is regret that he should not have used the vast influence he possessed to rid himself summarily of the need of lengthy and barren discussions on purely military matters. On the other hand he was assuredly loath to use this power unnecessarily, and perhaps thought it better policy to endure the inconvenience so long as it did not jeopardise matters of real moment.

It is needless to say that the writer is not among those who hold that for Lord Kitchener's fame it was well that the end came when it did—at a time when his opportunity of useful service was over. The facts seem to point to a directly opposite conclusion. Had he survived, he would assuredly have held the post of War Secretary to the end. No Premier would have displaced him; the combination of Lord Kitchener and Sir William Robertson, supported by public opinion in this country and among our Allies, would assuredly have defeated assaults from whatever quarter. When in due time the real history of the doings of the War Council from 1916 onwards can be written, the narrative will demonstrate how much we lost when the *Hampshire* went down. But for this tragedy our commanders in the field would have had more consistent and better instructed support; the varying strategy and the lapses in the matter of man-power which nearly brought us to disaster in March 1918 would have been avoided, and to quote Lord Haig once more, "Perhaps the victory would have come to us sooner had he been with us to the end."

He who saw so clearly at Vereeniging would have been a great asset at the Peace Conference; whether his view would have coincided with that of Marshal Foch, as Lord Esher suggests, the writer is disposed to doubt.

The thought arises too of the position Lord Kitchener would occupy among his fellow-countrymen were he still alive, similar to that which, as recorded in the pages of Greville, the Great Duke held in the closing years of his life. Alas! that the Fates willed it otherwise.

Space is limited, and the time has come to take leave of the latest of England's great men. To those who knew him the memory will always remain of the tall figure, the commanding personality, and the inscrutable countenance, reminiscent of that face which overlooks the land where he first found fame, and, like it, suggestive of the great attributes of Wisdom, Foresight, and Strength.

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The happiest recollection perhaps recalls him when inspecting the men he loved so well, the Volunteers of 1914–15, with their eager responsive faces, the flower of England who had so readily responded to the call; as they swung past him how little did they think that his warfare would be accomplished before theirs had well begun!

Let us hope that ere long the 5th of June, the date on which this noble life was lost, will become a Kitchener Day on which English-speaking folk throughout the Commonwealth will celebrate the memory of a great man, and will thank God for the instrument provided in their day of need.

Musing on these things, another Horatio comes to mind, one famous in Roman legend and in English ballad. Our feelings towards our great departed should be akin to those which the men and women of Ancient Rome entertained for their Captain of the Gate:

And still his name sounds stirring
  Unto the men of Rome,
As the trumpet blast that cries to them
  To charge the Volscian home;
And wives still pray to Juno
  For boys with hearts as bold
As his who kept the bridge so well
  In the brave days of old.

When the goodman mends his armour
  And trims his helmet's plume;
When the goodwife's shuttle merrily
  Goes flashing through the loom;
With weeping and with laughter
  Still is the story told,
How well Horatius kept the bridge
  In the brave days of old.

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WATER SUPPLY IN THE GREAT WAR.

Work of the Royal Engineers.

(*Reproduced by the kind permission of the Editor of* WATER AND WATER ENGINEERING).

A RECORD of the work of the Royal Engineers on the Western Front of the theatre of the Great War has just been published* by the Secretary of the R.E. Institute, Chatham, as one of a series of volumes dealing with the various branches of military engineering connected with the campaign. The account here given of the development and evolution of a system of water supply on a scale commensurate with the needs of an immense army in the field is of the greatest interest as a military document, and is of no less importance in other spheres of activity where large concentrations of men and animals are necessary for temporary purposes. So perfect had the water supply organization become towards the close of the war, that concentrations of military forces of any magnitude could be undertaken at the shortest possible notice, without any danger of breaking down owing to inadequate water-supply, and without reference to the hydrological conditions of the area concerned. The importance of this fact is evident, since it enabled the military authorities to eliminate the water-supply factor from serious consideration, and to conduct operations purely on stragetical or tactical grounds. The main features of this organization included the creation of a water-supply staff, the provision of mechanical plant for obtaining and purifying water, and of suitable means for its conveyance to any desired locality.

The various phases in the evolution of this system were naturally controlled by the exigencies of the situation in the various areas of operation, which covered a wide district extending from Flanders to the valley of the Somme. The initial difficulties were considerable, since the ordinary sources of supply, suitable for the needs of a normal population in times of peace, were quite inadequate for an army in the field. In Flanders especially the conditions were distinctly unfavourable. Surface supplies were liable to contamination, and deep-well borings were of an unpromising character. The chalk in that area is not water-bearing, owing to its argillaceous character, and the beds below the chalk are usually impregnated with soluble mineral matter and yield an unpotable ferruginous water. Public supplies in the neighbourhood of Ostend and Bruges are dependent solely upon shallow wells and canals. It was therefore necessary to make adequate provision for sterilizing such water as was procurable from these sources. Further south, in the area south of the Boulogne-Aire-Valenciennes line, conditions were

* *The Work of the Royal Engineers in the European War*, 1914–19—*Water Supply* (*France*). Published by the Secretary, R.E. Institute, Chatham. W. & J. Mackay & Co., Ltd. 1921. Price 25s.

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more favourable, since water-bearing chalk is generally to be found at depths ranging from 100 to 200 feet below the surface. Still further south in the Lys area the depth of the water-bearing chalk is greater, but the wells are artesian and supplies can be readily obtained by boring.

Coming to the chalk area between Arras and the Somme, and between the Ancre and the Escaut, an almost complete absence of surface water was an important consideration in any projected advance of the armies. This difficulty was met by the establishment of water supply points at suitable places along the Front, the installation of pumps and piping and the establishment of a system of motor transport for conveying the water in tanks, holding 600 gallons each, supplemented by water carts. The requirements of six corps involved the provision of 191 motor lorries and 480 water carts, with the necessary purification plants.

The purification plants included six filtration barges, on which plants by the Ransome VerMehr, Messrs. Bell Brothers and United Water Softeners were represented. These barges were fitted with well-equipped laboratories, qualified chemists and pumps. They did excellent service on the Lys, Iser and later on the Somme, pumping purified water into pipe-lines which reached lengths up to nearly five miles. Later, similar barges were ordered for use in Mesopotamia.

The Water Tank Companies had special purifying sections, supplied with Wallace and Tiernan liquid chlorine apparatus, rendering it possible to reach an output of over 1,000 gallons of purified water per hour from each sterilizing lorry.

For the comparatively waterless chalk plateau, in order to provide adequate supplies as far forward as possible in the event of an advance, power pumps were installed, with capacities ranging from 2,000 gallons to 7,000 gallons per hour against heads from 200 to 350 feet. These, together with 120 miles of 4-inch steel piping, made a heavy demand upon the available resources in England for plant of this kind. When an advance took place pipe-lines were laid forward as soon as possible, and new water points were established at their head.

These arrangements, however simple they may appear, thus baldly stated, involved a very considerable amount of military organization, the details of which are duly recorded in the volume before us. By the time of the opening of the Somme operations on July 1, 1916, over 100 power pumps had been installed in the Fourth Army area, and nearly 120 miles of water mains had been laid. These were continually increased as the operations proceeded, and suitable arrangements were made for the care and repair of the power machinery, which included semi-Diesel and petrol engines, as well as Hornsby oil engines. The boring plant, which was in use in the chalk area from early in 1915, was rendered more efficient by the adoption of the air-lift pump. The maximum quantity of water raised from a 6-inch borehole by an ordinary pump was about 3,000 gallons per hour. With an air-lift this was increased to 6,000 gallons, and in suitable positions to 10,000 gallons per hour. In the Ancre valley it was found possible to raise as much as 30,000 gallons per hour from one bore by using two air-lifts simultaneously. As the demand for boreholes increased it was found necessary to augment the water-boring sections with a crew of 12 men each.

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Rates of drilling up to 100 feet per day were achieved, and about four days sufficed to complete a 6-in. bore, 350 ft. deep. The success of the water-supply organization was greatly assisted, both in the saving of time and labour, by the appointment of a geologist, who prepared a valuable series of water-supply maps for the various areas concerned. The work carried out in this department is to be described in detail in another volume,* in course of preparation, which we shall hope to notice in due course.

In Part II. an account is given of actual operations, beginning with the Somme. In this area, where the Fourth British Army was established in March 1916, arrangements for an advance had necessarily to provide for the supply of troops and horses on a practically waterless plateau, for which purpose a Memorandum on Advanced Water Supplies was issued, and the chief part of it is here reproduced in full. The careful attention that was given to the smallest detail will be a revelation to many who have not had experience of military operations of this magnitude. The results of actual practice under war conditions are carefully recorded and will be of invaluable service for future reference. There were inevitable miscalculations owing to the unexpectedly large number of horses required for moving ammunition and supplies, and it was found necessary to supplement the pumps with a number of London County Council fire engines. The magnitude of the task may be gauged from the fact that at some horse watering points as many as 20,000 horses were watered daily, and at one trough a L.C.C. fire-engine was seen pumping 10,000 gallons per hour direct into the troughs without ever getting them filled. Space considerations prevent us from mentioning many interesting episodes in the advance in this area, where at the height of the battle water had to be provided for about 300,000 men and 150,000 horses, for which purpose it was necessary not only to pump 1,250,000 gallons a day, but to carry in addition 100,000 gallons by road. Another interesting point is that the French system of water supply differed from the British in having a very large number of small local pumping stations instead of a few large capacity stations with extensive pipe systems. Hence when the British Army took over a portion of the French lines there was at first some difficulty in adjusting the skilled personnel to the new conditions.

The conditions in the Arras area were specially interesting because this district is in Artois, from which the name "artesian" is derived. The whole area, in fact, is prolific in artesian supplies, nearly every large farm possessing a well of this character. The rapid extension of this supply was greatly helped by the preparation in advance of sub-surface water contour plans by the geological staff at General Head-quarters, so that an indication of the depth of the water table was available. Thus, on the summit of the Bapaume plateau, many miles from any surface water, five boreholes, put down in the course of a couple of months, yielded about 400,000 gallons a day with no apparent reduction of the level of the ground water, 100 metres below the surface. We must perforce pass over the history of the various episodes of the war chronicled in this volume, each one of which involved some

* *Work in the Field under the Engineer-in-Chief, B.E.F.: Geology.*

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interesting problems of water-supply. The conditions varied greatly in the different sectors of the front, and the success with which the difficulties were overcome is a monument to the perfection of the organization of the special service responsible for this vital task.

We have selected but a small fraction of the detailed information set forth in this interesting record. The experience alone is well worth the careful study of every water engineer. The book contains a large number of photographic illustrations, and many plates and maps. It furnishes a fund of information which for all time will be of inestimable service as a guide to practice under emergency conditions, such as may easily arise, although perhaps on a small scale, at any time and in any country.

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REVIEWS.

TWO ART BOOKS.

1 PRINTS OF BRITISH MILITARY OPERATIONS. By Lt.-Col. C. de W. CROOKSHANK, late R.E., H.M. Bodyguard. (Adlard and Son, and West Newman Ltd. Price £2 2s., or with Portfolio of 16 Plates, £10 10s.)

2. YPRES TO VERDUN. A Collection of Photographs of the War Areas in France and Flanders. By Sir ALEXANDER B. W. KENNEDY, LL.D., F.R.S., Past President of the Institution of Civil Engineers, Associate Member of the Ordnance Committee. (*Country Life*; Price, 15/-.)

In " Prints of British Military Operations," Lt.-Col. Crookshank has produced a *Catalogue Raisonné* of prints covering the period of British military history from the Norman Conquest to the Abyssinian Campaign of 1868, which will appeal not only to lovers of beautiful books, but also to all those, and their number is legion, who at some period of their life are interested in old engravings, and more especially in old battle scenes. The book contains some beautifully executed reproductions, notably Orthes and Bhurtpore, and forms a worthy companion to the catalogue of Commander Sir Charles Custs' Naval Collection. To some extent it also justifies the author's hope that it may help to illustrate the pages of Fortescue. We are not aware that any enthusiast has yet attempted the task of extra-illustrating Fortescue, but the volume under notice gives us some idea of the interest which might be found in that gigantic task and we can fully appreciate the zeal and industry with which Lt.-Col. Crookshank has completed this lengthy catalogue. The plates in the portfolio include some fine specimens of British colour printing. The book has been accepted by H.M. the King.

In " Ypres to Verdun " Sir Alexander Kennedy, with the help of over one hundred and twenty excellent photographs, takes the reader on a very interesting tour of the French Battlefields and enlivens the way with pleasant discourse and many interesting anecdotes. His motto is rather" Lest we Forget," than the passage which he gives from Colonel Bramble, and his quotations from the *Journal of Sister Marguerite of Ypres*, together with his pictures of the desolation of Hooge and Gheluvelt and the pitiful ruins of Ypres and Albert should well preserve the memory of what our neighbours suffered from the appalling destructiveness of the methods of modern warfare and of the heroism with which these methods were met and conquered.

F.E.G.S.

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NOTICES OF MAGAZINES.

MILITÄR WOCHENBLATT.

No. 18.—*The Downfall of the Central Powers*, by Karl Nowak, is reviewed with crushing moderation by Gen. von Kuhl (Chief of Staff to von Kluck in 1914). The author attacks Ludendorff and exalts Hoffmann, whose share in the Tannenberg victory has, he says, never been properly appreciated. Among other things of which Ludendorff is accused is half-heartedness in the March 21st attack! He is also declared to have been lacking in imagination and to have been merely a man of statistics and figures. By way, presumably, of showing what imagination really is, the author says that Ludendorff threatened von Arz, the Austrian C.G.S., with a declaration of war in August, 1918, and complains that Ludendorff could never grasp the idea of an attack on the Western Powers by way of the Italian plain, with its base at Genoa. The interest lies, not in the book, but in the fact that such a big gun as von Kuhl should think such nonsense worth a shot.

Austria.—Herr Baugoin, who has been Defence Minister for the last six months, is retiring in accordance with an agreement between the Christian-Socialist and National parties. He is said to have done good work. Col. von Wachter, an infantry officer who did very well in command of a regiment during the war, succeeds him. The *M.W.B.* hopes great things from this appointment and especially looks forward to close *liaison* between the German and Austrian defence ministries with a view to their helping each other to deal with difficulties common to both.

French Casualties.—The following figures of deaths are given for the French Army:—1914, 301,324; 1915, 348,867; 1916, 252,286; 1917, 163,716; 1918, 235,374; total, 1,301,567.

These were distributed as follows:—

Arm.	Total Deaths.	Percentage of Strength.
Infantry	1,142,238 ..	18
Cavalry	20,636 ..	5
Artillery	79,678 ..	2
Pioneers	26,832 ..	3
Air Service	3,696 ..	2
Train	10,243 ..	2
Others	15,233 ..	1

Arrest of Officers.—Some 40 ex-officers of the former 56th Infantry regiment were rash enough to hold a meeting at Krefeld and were promptly arrested by the Belgian troops in occupation, much to the annoyance of the *M.W.B.* The number of such meetings in the rest of Germany seems to be increasing and in this number about 35 are announced.

No. 19 contains little of interest.

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No. 20.—*More Officer-baiting.*—Some time ago a Brunswick minister Herr Sepp Oerter, speaking in his official capacity, said in a Brunswick paper: "We have had to pay a householder 15,000 marks, largely on account of stolen silver. The payment covered the period when Gen. Maerker and his officers were quartered in the house. About 100 silver spoons and forks were missing." On this Gen. Maerker took action and declared that Oerter himself was quartered in the house during the period in question. Oerter replies: "I forgive Gen. Maerker the lies he tells, because I know that it is the nature of 'Kaiserlich' generals to lie.' There seems to be very little redress in the courts for such remarks and the *M.W.B.* thinks so long as they continue there is little hope for the country.

The Railways on the German Right Flank during the Battle of the Marne.—In the allotment of blame for the Marne, the railways have naturally come in for a share, and Major Kretschmann now defends them. He says that, thanks to the absence of any extensive demolitions, it was possible on 30. 8. 14 to have a railhead at Cambrai, with a double line back from it *via* Valenciennes, Mons and Brussels.

On 4. 9. 14 the service reached St. Quentin but could get no further south, owing to the destruction of the bridge over the Crozat canal.

On 3. 9. 14 Peronne, on 4. 9. 14 Roye, and on 5. 9. 14 Chauny were reached; the first troops being detrained at Roye on 7. 9. 14. Compiègne was receiving trains on 9. 9. 14, and on the same day a railway construction company was working on restoring the Compiègne-Creil line. There was therefore a complete and independent line right back from the right wing to Germany, in working order by the time the Marne was fought. Of course it was not perfect, because numerous small demolitions, and especially lack of water-supplies, limited its efficiency. Though demands for troop movements could not always be met, it was always equal to the supply situation, thanks to the hard work of the railway troops.

The Lepel (43rd Inf.) Brigade during the Battle of the Marne.—This brigade consisted of the 72nd and 94th Reserve Infantry Regiments, under command of Gen. von Lepel. It was in Brussels up to 30. 8. 14, on L. of C. duty, but marched on that day to the south. On reaching Hal it was alarmed an hour after arrival and ordered north on Ninove. After a trying night march the alarm turned out a false one and the brigade resumed its move southwards. By this time it was entirely on its own, and continued so till on 8th September it reached the Army in Verberie and was allotted a few cavalrymen for reconnaissance. It had marched 40 kilometres on the 8th, but nevertheless was alarmed at 2 a.m. on the 9th and told that it was to act as flank guard to the First (von Kluck's) Army. A little later, at daybreak, it received orders to act against the flank and rear of the enemy, while the First Army attacked on the front Crepy-en-Valois-Meaux and southwards.

Accordingly at 5 a.m. a move due south *via* Racy-Rully-Ducy was begun and by 8 a.m. the high ground between Ducy and Baron was reached. At about 10 a.m. some French cavalrymen were sighted and dispersed after a few shots, the first which the Lepel brigade had fired. Shortly afterwards the brigade came under heavy rifle fire from the

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village of Droiselles and deployed for attack. After a stubborn fight the village was taken at about 3 p.m. and the enemy pursued for 2 km. south of it, till at 4.30 came the order to retire. There seemed to be no reason, locally, for the withdrawal which was carried out in perfect order and unmolested *via* Roxier and Rully.

The writer states that a French medical officer captured during the day was by order of Gen. Lepel provided with a horse and complete equipment and released " in accordance with international law."

Another account of the attack made by the brigade says that the fight was for long undecided, and, late in the afternoon, when the sounds of the First Army battle had nearly died away, only two companies remained in hand. About this time a French cavalry division (? Gillet's) with artillery was reported in rear of the brigade and one squadron threatened the two Landsturm batteries supporting the brigade. Von Lepel concluded that the First Army had been victorious, but for some reason unknown to him was unable to follow up its success. As for this brigade, it was in a tight place and if it remained where it was would certainly be wiped out or captured. He decided at 6 p.m., as the moment was favourable to break off the fight, to retire and did so in good order. The enemy infantry had been too roughly handled to follow, but the audacity of the French cavalry was, it is said, astonishing. However, von Lepel got away his brigade almost intact, only a few detachments failing to receive his orders and lying out facing the enemy all night. The writer thinks that the fact that the brigade took prisoners from six different regiments shows that it materially lightened the task of the First Army.

No. 21.—*The Road to Revolution.*—By Gen. von Wrisberg.—Sets out " to show the thinking portion of the German nation who it was that handed it the cup of poison." The hope, which was held in 1914, that the social-democratic party would become a truly national party, vanished in 1915, when it became clear that a short war was out of the question, and in 1916 the break-off of the left wing of the party laid the foundation of what soon became the " Independent Socialists' Party " which conducted energetic peace propaganda. The two chief factors leading to this were the delay in the Prussian Electoral Reform Bill and the increasing pressure of the blockade. Gradually the idea was spread through the masses that Germany had but to submit and her " comrades " in other countries would see that she came to no harm. A flash, which revealed the coming storm, was provided by the mutiny in the fleet in July, 1917, which was repressed, two of the ringleaders being shot and 50 sent to penal servitude ; but the real business began when on 9th February, 1918, Emil Barth took control of the Independent Socialists and worked steadily towards his objective, an armed uprising against the Government. Ceaseless propaganda on the L. of C. directed chiefly against men returning from leave and the younger recruit classes carried the poison into the Army and weakened its powers of resistance. Hitherto the Government has always refused to face the truth concerning these doings, but sooner or later it will have to do so and von Wrisberg's book will be of great value in creating a demand for full investigation.

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Training of Officers and N.C.O.'s in the Austrian Army.—This seems to go badly; an attempt to obtain uniformity by establishing schools for N.C.O.'s was put down by the mission of control, while the scheme for producing officers has fallen under the ban of the Socialists. The intention was to take youths with a good education and train them for two to three years to be officers. The Socialists say that this will result in the officers all coming from the *bourgeois* class, since the proletariat cannot afford education up to the necessary standard. They demand that the education shall be given in the Army, though it is admitted that this will involve six to eight years' training in all before a candidate can become an officer. At present things are at a deadlock. In other respects the national feeling towards the Army seems to be improving, and the long spell of duty on frontier guard seems to have brought officers and men more closely together.

L. CHENEVIX-TRENCH, *Major, R.E.*

REVUE MILITAIRE GÉNÉRALE.

September, 1921.

The Revision of the Regulations.—By LUCIUS. (*Continued*).

The German Attack on Verdun.—The Germans regarded Great Britain as their principal enemy, but it would require 30 Divisions to attack on her front, and to concentrate these would mean unduly weakening their lines elsewhere. Falkenhayn estimated that France was militarily and economically exhausted, and recommended the attack on Verdun, not so much in the hope of breaking through, but in order to inflict on France such a blow, in a spot where she must employ her last man, that Great Britain would be left practically single-handed. Impressed by the rapid reduction of the Belgian and certain French fortresses early in the war, the French had decided to organize the defence of their remaining strongholds well in front of the permanent works, to withdraw the infantry garrisons of the forts and to place all the troops under the C.-in-C. of the field army in which they happened to be situated. As already stated, the defences of Verdun were organized by centres of resistance separated sometimes by considerable intervals and with no communication trenches to the rear, the shelter of woods and hedges being relied on for concealment of movements. On perceiving indications of an attack two infantry divisions were sent up to help in the completion of the new works of defence.

The Germans strove to attain strategical surprise (1) by leaving it uncertain whether they would attack in Champagne or in Lorraine, (2) by not constructing parallels of departure (some of their trenches were 600 to 800 yards away), (3) by camouflage, (4) by refusing to reply to any French bombardment however heavy. Tactical surprise was secured by the rapidity and weight of the artillery preparation, by bombarding on a front of 22, and attacking on a front of $7\frac{1}{2}$ kilometres only, and by furious infantry attacks scarcely leaving time for the defenders to issue from their shelters. The tactics aimed at inflicting heavy losses

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on the defenders and economizing the attacking troops by strictly limiting their objectives. The guns shelled to a great depth, and after several hours increased their intensity on the point of attack without relaxing on the others ; after the assault they continued to fire beyond and on the flanks of the point of attack, then concentrated on a fresh section of the bombarded front where a new infantry attack was launched. Aimed fire was not used and the counter-battery guns fired gas shell to neutralize, instead of attempting to knock out, the French guns. The infantry was distributed in depth with orders to occupy the captured position in great depth, and not to advance beyond a prearranged line unless very exceptional circumstances clearly justified such a course. The German division attacked on a front of 1,000 to 1,200 metres as against the 1,500 to 2,500 metres of the French, but when the enemy position was not to be penetrated to a great depth the divisional front was sometimes extended to 2,500 metres. Orders were given to manœuvre the defenders out of their centres of resistance by infiltration into the passive zones, in fact, always to effect a lodgment in two or more points and then carry the intervals by combined frontal and flank attacks. Strong reconnaissances of 2 officers and 50 men preceded attacks to see if the artillery preparation had been sufficient, and no attack was to be delivered until the position had been reduced to powerlessness. Such rigid commands left nothing to initiative or to the unforeseen, and did not go so far as to give instructions on the exploitation of a success.

Owing to uncertainty as to the point of attack the troops covering Verdun had not been reinforced, but early in February an army of four Corps with some heavy artillery was collected in rear. There were nine Divisions of infantry in line, and six regiments of heavy artillery dispersed over the two banks of the Meuse (612 guns, of which 244 heavy) against 17 and soon 19 German divisions and 2,000 guns of which the larger proportion were heavy. The battle consisted of two phases, the first a step-by-step defence unable definitely to stay the attack, the second commencing when the offensive on the Somme checked the attack on Verdun and again gave the initiative to the French. The causes of the eventual German defeat are, first, Falkenhayn's mistake regarding the exhaustion of the French ; others are the too narrow front of their infantry attacks, and the formalism of their orders. On 24th February the road to Verdun was open and a bold advance would have carried the Germans at least to the heights of Belleville. Again their attack on the left of the Meuse was delivered too late, and the coolness and energy of the French commanders of all grades was of enormous influence on the result. Nor was France weakened to the extent expected. Two-thirds of her army passed through the fire, and at the beginning of the battle of the Somme she could only send 12 infantry divisions and 700 heavy guns instead of the 39 and 1,700 respectively promised, but by the end of August she sent up 13 more divisions and 500 more guns. The Germans were almost as much weakened, and Ludendorff afterwards described Verdun as "an ever-open ulcer devouring our forces."

A. R. REYNOLDS.

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REVUE MILITAIRE SUISSE.

No. 7—*July*, 1921.

The Franco-Swiss Military Convention of 1917.—The original article is from the pen of Colonel Feyler, who gives details of the scheme which was worked out jointly by the General Staffs of the French and Swiss Armies in the beginning of 1917 to meet the contingency of a violation of Swiss neutrality by the Central Powers. Colonel Feyler points out that the possibility of the Germans invading France via Switzerland first came under serious consideration at the French G.H.Q. in the winter of 1915-1916. A reconnaissance of the routes of the Juras was accordingly ordered and carried out by the automobile service. During the winter of 1916-1917, the matter came into prominence again, and the problem was studied afresh. Finally, in the winter of 1917-1918, the Germans having succeeded temporarily in obtaining a numerical superiority on the Western Front, it was expected that they would attempt a deployment upon a grandiose scale, and for the third time, the French General Staff returned to the consideration of the problem. Colonel Feyler discusses more particularly the plan worked out in the winter of 1916-1917; this plan was based upon the assumption that the Swiss Army would have to hold its own against the Germans for seven days before it could receive support from the French. The general idea was that the Swiss Divisions should take up a position on the line Lausanne—Chaux-de-Fonds, where it might expect to be reinforced by four French Divisions in from four to seven days—in the case of 1917-1918 plan, a much shorter time was allowed for the arrival of the French reinforcements, namely, two days for the arrival of the first four Divisions and a third day for two additional Divisions. Colonel Feyler discusses the courses which would have been open to the Swiss had they been obliged to retire from the frontier, and compares the situation with that which actually came to pass in Belgium when the Belgians had to fall back from the Meuse.

Military Bridges.—The original article is based upon one on the same subject appearing in the *Royal Engineers Journal* for February, 1921.

The Reichswehr.—The original article is contributed by Major de Vallière who gives some important information, based upon the utterances of General von Seeckt and others, as to the manner in which the Teutons hope to defeat the provisions of the Treaty of Versailles, the object of which is to limit Germany's armed forces and to keep a check upon their expansion. General von Seeckt is stated to have announced in an Order of the Day that the Reichswehr was "*destined to form the back-bone of our national forces in the hour of danger.*" In accordance with the terms of the Peace Treaty this force was reduced to 100,000 men of all ranks some time ago; but of its 4,000 officers no less than 54 are generals (approximately one general for every 1,800 other ranks); it is said also that non-commissioned officers are mustered as privates. Further, it would appear that a number of organizations have sprung up in Germany, which, although nominally non-military, are nevertheless capable of being easily transformed into a fighting force and could be readily incorporated into Germany's small standing army.—(*To be continued*).

NOTES AND NEWS.—*France.*—A special correspondent refers to the

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provision made in the draft of the new Military Law for the assimilation of the officers of the various "services" with those of the combatant arms: the scales of pay are apparently to be unified, but the officers of the "services" are still to retain their former titles. A new scheme in relation to promotions is also mooted, as well as new regulations relating to entry into the commissioned ranks. In order to obtain a commission a young man will have to spend at least two years at one of the cadet schools and to pass the examinations of the school; alternatively he may serve three years in a Corps, at least two of them as a non-commissioned officer (*i.e.*, in a rank higher than that of corporal), and he must go through the course of instruction at one of the schools for non-commissioned officers and give satisfactory evidence that he has reached a sufficient standard of proficiency; in the further alternative, he may serve for six years in a Corps, at least four of them as a non-commissioned officer, and he must hold the rank of "adjudant" or "adjudant-chef" (the latter is the highest grade in the N.C.O. ranks). The foregoing periods may be halved in the case of men on active service. The rank of major has been abolished in the French Army. In future, two-thirds of the battalion commanders are to be promoted by a process of selection, the remaining one-third will be appointed on the principle of "seniority tempered by selection." The promotion of subalterns is to be carried out on the recommendations of Regional Commissions which will be presided over by the Corps Commanders. These Commissions are required to keep lists showing the qualifications of the officers of the Command and to transmit such lists periodically to a Central Commission. The Central Commission will be presided over by a member of the *Conseil supérieur de la guerre* and the Inspectors General and the Directors of the various arms and services will be members at the meetings of the Commission to adjudicate upon the claims to advancement of the officers of their own arm or service.

No. 8.—*August*, 1921.

The Fate of a Great Army.—The author of the original article, Capt. Cuno Hofer, calls attention therein to articles, from the pen of F. de Bolgar, the Hungarian politician, published in the *Pester Lloyd* of 14th and 15th May, 1921, doing homage to the memory of the late Marshal Boroévics, one of the most distinguished of the Commanders of the Hapsburgian Armies during the Great War; the death of this brilliant soldier occurred shortly after the crumbling to pieces of the old Danubian Monarchy. Boroévics first came into prominence as a Corps Commander in the Carpathians; subsequently, he fought a dozen celebrated battles on the Isonzo, and by his leadership on these fields has won for himself immortal renown. De Bolgar's articles are based largely upon letters written to him by the Marshal, wherein the latter discloses the chaos and utter state of unpreparedness in which he found the forces in command of which he was placed on his arrival at the Italian Front. It appears to have been largely due to the divided counsels which prevailed at the Austrian G.H.Q., the petty intrigues, and a total lack of material support that Boroévics was compelled to retreat from the Piave in the summer of 1918, after his brilliant stroke which placed in the hands of his Army 12,000 prisoners of war; an occasion upon which the Hungarians fought

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like lions. Capt. Hofer appears to be of opinion that Hungary has been somewhat severely dealt with by the conquerors, in that her military forces have been reduced to seven mixed brigades, with an establishment all told of 1,750 officers and 2,334 N.C.O.'s ; he expresses sympathy for the Hungarian soldiers, who, after having fought with conspicuous gallantry on the Isonzo, in Galicia, and in the Carpathians, have now to be content to live the humdrum life of a village policeman or of a customs' official.

NOTES AND NEWS.—*Belgium.*—A special correspondent contributes a few notes relating to the Belgian Army, the strength of which has been reduced to 115,000 men, but which continues to be organized in six Army Divisions, each containing two infantry divisions of three regiments. The other combatant troops consist of 21 artillery regiments ; one heavy artillery division (three regiments) ; a cavalry division organized in three brigades (12 regiments) ; and six regiments of engineers. Provisionally, the periods of colour service in the different branches are as follows :—infantry, 10 months ; cavalry, 13 months ; artillery, engineers and the technical branches generally, 12 months. Largely owing to the efforts of a group of patriots, civil and military, the Air Force is being placed upon a satisfactory footing and things are going well with the " fifth arm." Schools of instruction in aviation are growing in number ; they are run under civilian auspices, but the Department of National Defence patronizes and also subsidizes them. The Tank Corps is not so well off as the Air Force. The personnel is kept up to establishment ; it is alleged, however, that there is a shortage in equipment and much of that in the hands of the troops is of an obsolete type.

France.—Another special correspondent furnishes some particulars concerning the reorganization of the French Army : the chief points to which attention is called are as follows :—In future there will be 12 different kinds of infantry regiment, classified in main groups as infantry properly so-called, chasseurs-à-pied, zouaves, tirailleurs, foreign legion, " light tanks " and " heavy tanks ; " each with varying establishments. The establishments of these various kinds of regiments are briefly set out in the original notes. The cavalry is to be provided with a more homogeneous organization : except in the case of the Spahis, a regiment will consist of 22 officers, 650 other ranks, and 657 horses. The establishment of a Spahi regiment will be 23 French officers and 8 native subaltern officers ; the other ranks will contain 130 Frenchmen and 620 natives ; these regiments are to be provided with 799 horses and mules. There will in future be a great variety of units in the artillery ; in some cases the guns will continue to be horse-drawn, but in others tractors will be utilized for this purpose. The engineers will continue to be organized in specialized units as heretofore. The Air Force will also retain the organization evolved for it during the War : particulars are given in the original notes of the various types of aviation squadrons. France is much perplexed on the question of its temporary officers ; there are to-day some 14,000 of them, of whom about 8,400 were promoted from the ranks. The question of what shall be done to deal equitably by them is discussed at some length in the original notes.

W. A. J. O'MEARA.

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CHEMICAL WARFARE.

(*Lecture delivered at the S.M.E. on* 8. 12. 1921, *by* CAPT. S. J. M. AULD, O.B.E., M.C., 4th (Terr.) Batt. Royal Berks Regt.)

IT is at the risk of being written down as an exponent of the worst type of inhumanity and as a person with distinctly ungentlemanly ideas of soldiering that I introduce my subject by stating didactically and without preamble that I consider chemical warfare to be the warfare of the future.

In the military quiescence following the cessation of a great war comes the opportunity for reviewing the experiences of the past and building thereon, by the application of deduction and controlled imagination, the foundation of preparedness for the future. That is the position at present. The General Staffs of the world's armies are working unobtrusively, single-mindedly, and with what imagination they can bring to play, forecasting the future on the basis of the past.

But there are some truths too large for the imagination at once to grasp, some inductions apparently too fantastical to accept, and, if accepted, too much opposed to vested interests, to the condition of things as they are, to be adopted forthwith as fundamentals of progressive development. This is the position of what we have been used to call " Gas " warfare.

We have come to a forked road in the march of military progress. During the War, by force of circumstances and against our wish, we were induced for a short distance to follow the pathway of revolutionary change. Now, many seem anxious to return to the old road. Some, after a partial reconnaissance or no reconnaissance at all, claim that the new road leads nowhere and will only dirty our feet to no purpose by following it. Others realize whither the new road leads but are daunted by its prospects. To follow it seems to imply the eventual discarding of known and approved methods, a complete dissociation from old ideas and a general committal to the adoption of strange and, to the average soldier, unnatural, methods of fighting from which he shrinks.

My lecture to you to-night is intended to be a military one, but its value would be small if I neglected to make it perfectly clear that, whether we like it or not, Chemical Warfare has come to stay. It is inconceivable that the light barriers of mutual consent or of edict can effectively close the road I speak of. Military history and human

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nature are against it at every turn. No case is known of a successful new weapon or a tactical advantage having been discarded once its value was approved. No agreement or treaty has proved strong enough to bind an unscrupulous enemy seeking an advantage, or for that matter one with its existence at stake. To avoid the new road is to risk being passed in the race of preparation and being outflanked and overwhelmed in the event of hostilities.

Whatever we do in the matter we can bind no one but ourselves. Until War ceases we must be prepared. Apathy is suicidal. Prejudice is a crime.

When Germany broke faith with the civilized world in April 1915, and loosed on unsuspecting and unprotected men a cloud of chlorine, a new weapon was added to the world's armoury; the deadliest weapon so far invented by man had been forged. From that date till the close of hostilities the developments in chemical warfare were so far-reaching, so fundamental, that to think of gas, as many still do, in terms of 1915 is as anachronistic as thinking of to-morrow's battles in terms of Wellington's campaigns.

It is this failure on many sides to envisage the progress already made in developing the use of gas which has made it possible for anyone to consider the relegation of gas warfare to the past and carrying on future wars without it. A full knowledge of the past, and an appreciation of the possibilities of the future should convince every soldier that the use of poisonous and irritating gases is just as fundamental as the introduction of gunpowder, and probably even more so. Couple this conclusion with the belief that you cannot enforce the fulfilment of peace-time agreements during war, and you come to the logical conclusion that the country which does not regard chemical warfare as the very basis of its military preparations for the future is deliberately risking absolute and unmitigated disaster at the hands of its more progressive, or, if you will, its less scrupulous opponents.

The present dangerous apathy in the Army with regard to " Gas " is unquestionably due to three things; the " marking time " by the G.S. pending Government decision on the basis of international agreement, or disagreement, regarding the legitimacy of the weapon; the lack of knowledge on the part of officers—both senior and junior; and the lack of sympathy with the subject *in toto*, resulting from the natural feeling that it is a rotten way of fighting anyhow. But ignorance in all ranks is the chief reason. Once the veil is lifted the " merely brave " officer who wishes to charge the enemy " sword in hand " can have little weight. Surely none at all, if it is seen that the very existence of the country may be imperilled.

The widespread ignorance is due to three main causes:

In the first place it was almost impossible for the average officer who went through the War to gauge the relative importance of Gas

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from his own observations, however wide his personal experience. How many of those present, or indeed in the Army as a whole, who went through it all, are aware that in their last great offensive fifty per cent. of the German shell were wholly or partly chemical-filled? Or that of the American army, the only one for which classified figures are available, nearly thirty per cent. of the total casualties were gas casualties? Or that, towards the close of the war our Special Brigade, R.E., carried out attacks in which as much as 160 tons of gas were liberated on a short front in the space of a few minutes? Not many, I will wager.

Secondly, the officers who could and should have perpetuated the war knowledge of the use of gas and who might have provided the necessary continuity of appreciation of the subject have left the Army. Practically all the commissioned personnel, whether Advisers, Special Troops Officers, or Anti-Gas Officers, were non-regulars.

How many active regular and T.F. officers are acquainted even theoretically with the military technique of gas warfare? How many infantry battalions have established a tradition of anti-gas discipline consonant with their war history or the standard of their other training? How many young officers are taught to imagine all their field work—their company training and their tactical excercise—as punctuated by gas or the fear of gas? How many artillerymen have studied the science of using gas shell? How many gas shell are fired in practice at the Artillery School?

The answers to these questions are very disquieting to one with a belief in the future of chemical warfare. More, they are thoroughly alarming.

The reason is the hiatus which already exists between the knowledge of the Army in 1918 and to-day. It would be possible to count on the fingers the active officers of to-day who were intimately connected with the Chemical Warfare organization of the past. *Yet gas might easily have had us beaten on three separate occasions in the war, and to this I can add with some confidence that had Germany not retired when she did the Gas Service was in a position to operate with greatly increased effect.*

Then there has been the secrecy maintained about the whole subject; a secrecy which, concerning the past, has only very recently been dispelled at all. This secrecy has had unfortunate results. It has caused the subject to be viewed, even in the Army, in the light of the horrors of 1915—the only period at which considerable publicity was given to it in the press. It has obscured the consideration of the military value of gas and its legitimacy for future employment. Facts have not been allowed sufficiently to speak for themselves. There has consequently been too great an opportunity to decry the effects of gas on the one hand or to magnify its brutality on the other. As a result the significance of chemical

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warfare, its accomplishments in the past and its potentialities for the future have been largely denied to the people it affects most—the younger generation in the Army. A frank appreciation of these facts is needed—more, I think, than anything else—for it is a bald fact, which can scarcely be questioned, that the millions we spend annually on our armed forces is money wasted unless ample provision is made for the study and practice of chemical warfare.

If you believe in the possibility of a known and powerful weapon being eliminated from war by agreement, well and good. If not, then every staff and regimental officer who does not think gas and consider gas in every phase of attack and defence is falling short of his responsibility. You cannot say in effect—" Let's pretend we don't see it, perhaps it will go away." It won't go. However unpalatable the prospect you must be prepared to face it.

It is for the purpose of emphasizing these conclusions and not as the end itself that I will tell you what I can in general of chemical warfare in the short time at my disposal.

In the first place, as you are probably well aware, the term " Gas " is a misnomer. Chemical warfare is only " gas warfare " in the sense that the toxic or irritant chemicals used are at present carried by the atmosphere. Actually the substances are mostly liquids and finely divided solids. Even the true gases, when used, are reduced to the liquid form under pressure and only become gases again when their containers are opened or burst.

The offensive in chemical warfare comprises cloud attacks, and bombardments with projector drums, T.M. bombs and artillery shell. In each case the attack has two main objects—the infliction of casualties and neutralization. Generally speaking, the infliction of casualties is the more important because if sufficient in extent it achieves the second object more effectively and for a longer period. Also, since the most effective casualty is a permanent one, chemical warfare aims to kill where it can. The possibilities of this are dependent, however, on the amount and nature of the materials available. Indeed, all gas tactics will vary from time to time according to the nature of the enemy's protection and the type and quantities of the weapons and chemicals employed.

It is in this particular connection that the extraordinary power and potentiality of chemical warfare can be realized. The whole realm of chemistry is available for exploitation to provide new materials. In organic chemistry alone the possibilities are almost infinite. Consider the steady growth during the war of the toxicity and insidious nature of the chemicals used: First came simple asphyxiating gases like chlorine and the relatively non-toxic tear gases or lachrymators; then followed the more effective asphyxiants like phosgene and paralysants like prussic acid; close at their heels came the so-called sternutators or sneezing-gases, which were powerful

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mucous membrane irritants; finally the important stage of the vesicants—the skin irritants like mustard gas—which at the same time combined many of the properties of their predecessors. There were others, not so easily classified by the layman.

Each of these classes had numerous members which were adopted, used or discarded according to the ease of manufacture or employment, their field effect on men, and the protection attained against them by the other side. The Germans alone used between twenty-five and thirty different chemicals in the form of cloud gases or fillings for projectiles.

It is obvious then that this whole question, if treated at all, must be treated *fundamentally*. There is no shirking it, or going in for half measures. Certain general principles are involved, a number of tactical factors are constant, but the variables are so numerous that the possibility of taking up chemical warfare in a haphazard way, or as a mere adjunct to existing methods is bound to end in disaster at the hands of an enemy more thorough or better informed than ourselves.

The " variables " I would classify from the purely military aspect as—

(1) Weapons;
(2) Physiological effect of the chemicals;
(3) Physical properties of the chemicals;
(4) Quantity of chemicals available;
(5) Nature of the enemy's protection.

I would like to say a few words about most of these divisions as the best way of giving you a rough general oversight of the whole subject.

There are practically only three special gas weapons—the cylinder, the Livens projector and the toxic smoke generator.

In all the cloud attacks of both sides during the late war the gas was enclosed in steel cylinders ranging in weight from 90–120 lbs. when full, and after installation in the trenches was liberated when the wind was favourable and the atmospheric conditions good. This method is very crude but has nearly always proved very effective because of the ground it covers. Towards the end of the war it gradually fell more and more into disuse as other methods were developed because of the arduous and lengthy preparations required for carrying it through and the decreasing possibility of effecting surprise. Just before the close of the war, however, it enjoyed a wonderful revival in special circumstances by the organization of highly concentrated " beam " attacks, delivered from light trains instead of from the trenches. Around Lens and in the Ypres Salient, advantage was taken of the network of narrow gauge lines to bring up trains loaded with many thousand cylinders of gas which were

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discharged simultaneously by electricity. As many as 6,000 cylinders from three trains in echelon have been discharged over a short front in the space of a few minutes. The concentration of gas produced in this way is terrific, the element of surprise is much emphasized and the effects very marked.

The " beam " attacks were really a matter of increased mobility, and to this end much attention was also paid to making portable gas cylinders capable of being carried by one man and of being used in comparatively open warfare.

Gas clouds suffer, however, from an even greater disability than their clumsiness. The concentration of a gas cloud is greatest at the point of discharge and after that decrease as a function of the square of the distance. This is wrong. The concentration should be greatest on top of one's enemy ; not on top of oneself. It was to get over this objection that Livens invented his " projector."

The projector is simply an earth mortar—a steel tube buried in the ground at 45°, variation in range being obtained by altering the propellent charge. So simple was the design of these " guns " as used in the war that the electric wires for firing passed down the muzzle, alongside the drum or projectile to the charge. Yet this crude weapon was one of the most effective of the war. They were set by hundreds, sometimes by thousands, close behind the front trenches and were fired simultaneously by blasting machines. As the drums contained 30 lbs. of gas, the effect, for example, of the discharge of 2,500 at one time into Lens can be imagined. The projector is deliberately in no sense a weapon of precision. In its very crudity lies its genius. It simply allows the deadly gas cloud to be started, without warning, 500–1,000 yards closer to the enemy. It was adopted by all the belligerent armies, including Germany.

Of the toxic smoke generators I shall have something to say later.

Now, with regard to the pukka projectiles—the T.M. bombs and artillery shell.

Gas filled into 4-in. Stokes mortars was largely used by the Special Brigade, R.E., but there is little reason why gas-filled bombs should not in some circumstances be fired by ordinary T.M. batteries, and this is bound to come. Indeed, the Germans adopted this plan with much success, especially with their light Minenwerfer.

The great advantage of the Stokes 4-in. for chemical warfare is its rapidity of fire. Under battle conditions fifteen shots a minute can be got off. In this way, despite the relatively small amount of gas in the bomb, local high concentrations of gas or smoke can be produced with success. For surprise tactical purposes at close quarters or for vicious interference with everyday work in the trenches chemical-filled T.M. bombs were of the greatest use, but it is doubtful if we took full advantage of this in the latter stages of the war. I was with the American Army in the Battle of the Argonne, and it

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was really surprising how mobile the Yankees made this gun and how much they used it in open fighting. Their gas regiment, the 30th Engineers, was up with the infantry the whole time and accomplished some fine work in dealing with machine-gun nests with Stokes bombs filled with phosphorus or thermite. The guns were either man-handled or carried on pack animals or mounted on light improvised carriages. Transport of ammunition was the chief difficulty, but there is unquestionably a big future for the really mobile mortar of this capacity and range.

The genuine artillery chemical shell form a whole side of gas warfare by themselves. They have their own history, their own special technique and already well-developed tactics. Their importance in the warfare of the present is hardly grasped.

Artillery shell contain relatively little gas compared with projector drums or even T.M. bombs. Yet, despite this disadvantage, more gas was used in shell than in any other way. The reasons are chiefly these: Artillery rarely fire at ranges much under one mile; consequently their gas bombardments are practically independent of wind direction. The use of gas by artillery does not necessitate special personnel, nor does it interfere with the activities of other troops. By their rapidity of fire and co-ordination of fire direction, with or without previous concentration, the guns can put up such effective gas concentration as will meet the requirements of chemical warfare tactics. Moreover supply of ammunition to the artillery is better organized and much simpler than with other branches of the Service. It is small wonder, then, that with these advantages the amount of gas shell used was a constantly increasing one. But the actual quantities and the proportion attained to the total shell supplies are not generally realized.

When we started to use gas shell in 1915, less than 5 per cent. of the total shell were chemical shell. This proportion increased to 25 per cent. by 1918, with a prospect of still more for the future. The Americans, having seen most of the game from the outside, budgeted from the very commencement on at least 30 per cent. with the intention of going on to 50 per cent. The Germans during 1918 actually supplied their dumps with 50 per cent of chemical shell and in special operations used as much as 80 per cent of gas-filled shell.

These increased proportions, you must remember, referred to the enormously increased number of shell produced after the first year or so of the war, so that the actual quantity of gas fired by the artillery became very large. In the German bombardments of Nieuport and Armentières in 1917 and 1918 as many as 50,000 gas shell were used on limited objectives, and 200,000 rounds in one day over a single battle front was estimated as an inside figure.

The actual shell used by us were the 4·5-in. Howitzer, the 6-in. Howitzer, and the 60-pr. gun. The 18-pr. was only used for smoke,

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but the French, Americans and Germans all used field-gun shell filled with gas, and there is no question that with us it will come also, because of the accuracy and the rapidity of fire.

The great difficulty with artillery shell is the need of increasing the ratio Capacity/Weight, which at present only amounts to about 10 per cent. With Livens drums it is nearly 50 per cent. To increase the capacity of shell the whole construction must be revised, and this is a point to which much attention is being paid. Gas shell conforming to this requirement may have considerably altered ballistics and will not range the same as H.E. of the same calibre. This, however, is practically the only added difficulty to be met by the actual gunners in firing such projectiles, and with increased capacity the efficiency for all purposes will go up in leaps and bounds.

Now, with regard to the chemicals themselves: These range from compressible gases, through high-boiling liquids up to apparently inert solids. Physiologically they cover an equally wide range, as I mentioned previously. With their chemical nature and even with their physiological effects I will not worry you. Their tactical classification is more important. At present we simply divide the "gases" into two kinds—persistent and non-persistent. Each of these classes can then be subdivided into lethal and non-lethal. This gives us a line right away on chemical warfare tactics, for it is obvious that an irritant or poisonous gas which persists, possibly for hours, may be as objectionable to the attackers as the defenders, should the former anticipate traversing the same ground.

As I mentioned before, the two chief objects of chemical warfare are the infliction of casualties and neutralization. If sufficient casualties can be inflicted neutralisation is also effected, but so far, the casualties, though enormous, have never been sufficient in themselves to produce results of the strategical value of neutralization. Indeed, there were many cases in the last year of the war where the casualties produced by a heavy bombardment were of secondary importance—merely incidental to the denial of mobility and terrain to the other side.

Nevertheless, the gassing of the enemy's personnel is most important, since it reduces his man power and affects his *morale*. Casualties can always be inflicted by surprise—either the surprise of tactics or materials—and as a result of bad gas discipline. Less certain, but still probable, are casualties arising from exhaustion of the enemy's protection or from his inability to remain protected over long periods.

Gas cloud and projector attacks aim chiefly at producing casualties. For this reason the deadliest gases and the highest concentrations are aimed at in order that the minimum amount breathed may cause serious injury. During the war little hope was entertained of penetrating the German respirators with our lethal gases. Con-

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sequently the most important element of cloud and projector tactics was "surprise"—generally the surprise of secret preparation, but sometimes the surprise of tactical use, such as making several successively stronger attacks on the same night; alternating gas clouds with innocuous smoke clouds and so on.

Although the possibility of exhausting the enemy's masks was not great during the war, yet in the event of a siege, where renewal of the gas mask would be impossible, it would assume great importance. Under these conditions the enemy would be helpless after a few discharges.

Actual penetration of the enemy's protection is, of course, the desideratum of chemical warfare. Assuming this to be attained, the enemy is defenceless and incapable of resistance. He will be overwhelmed over the whole front attacked, and if this front is sufficiently extensive he must break completely. We were in a position of this kind in 1915, but fortunately the front attacked was too short and the German reserves of gas too small to effect the complete smashing which was possible.

Again, in 1917, the Germans had produced a device which emitted a gas capable of penetrating our respirators. Fortunately for us their own professional dissensions, which prevented sufficient faith being placed in the discovery, coupled with consistent misfortune in weather conditions and a timely advance by the French on to the prepared positions, caused its withdrawal to the Eastern Front, where it was lost sight of in the confusion of the Russian *débacle*. Subsequently the material was used in shell—the celebrated Blue Cross or sneezing-shell—but in this form its action was not the same.

By the end of the war the tables were turned and we had the Germans at our mercy with a similar material, used effectively. The idea was the production of a toxic smoke instead of a gas or vapour. You know how difficult a finely divided smoke, like tobacco smoke, is to filter out through cotton wool. That is the principle of the "particulate cloud." Respirators designed to stop true gases and vapours simply will not touch it.

Even when an enemy is able to recognize a gas attack and to adjust his protection in time, a considerable tactical advantage is gained by compelling him to retain it. Inconvenience is caused, activity is greatly restricted and vision interfered with, especially at night. The discomfort of prolonged wearing of gas masks is very great and requires the strictest discipline to support, especially when the gas outside is not immediately intolerable. Heavy tasks, like digging and carrying, are interrupted owing to the increased exertion of breathing, and the duties of observers, wiring parties and, in fact, everyone, suffer considerably.

Neutralization of this kind is best effected by means of persistent gases, since they hang about for a long time and require comparatively

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little expenditure of ammunition. The work is almost wholly that of the artillery. At first lachrymators were used and these non-lethal persistent substances are still employed where immediate results are wanted and on ground which it is hoped shortly to occupy, especially if it is impossible to cover it sufficiently with lethal non-persistent materials like phosgene. The tear-gases themselves are merely annoying, but annoyance may be an effective method of neutralizing infantry. For instance, where large amounts of supplies and ammunition are being brought up there are always cross-roads where there is confusion and interference of traffic. A few gas shell placed there make every man put on his mask, and if it is a dark night and the roads are muddy the resulting confusion can be only faintly imagined. It may thus be possible to neutralize a part of the infantry by cutting down their supplies and ammunition.

If, however, you can hurt a man at the same time as you neutralize him, so much the better. Hence the development in gas shell tactics which consisted of using materials which were persistent and also poisonous. The material of the war for this purpose *par excellence* was the notorious mustard gas. Its introduction was probably the greatest single development of chemical warfare.

As youare probably aware, mustard gas remains about a bombarded position for hours or even days. In addition, it has a most caustic blistering action on the skin. The combination of these properties to a great extent removes the necessity of surprise tactics, since its immediate effects are not very marked.

It was first used by the Germans in July, 1917. Its tactical value was quickly recognized and during one period of ten days in the succeeding autumn it was calculated that 1,000,000 shell were fired, containing about 2,500 tons of mustard gas. Our casualties were very large and practically every casualty required evacuation, though the actual deaths were very few. Its toxicity compared with other gases is not great, and only about 1 per cent. of the casualties die, but its vesicant action is extraordinary. One part in three to five million will cause a skin burn on a sensitive person on prolonged exposure and with higher concentrations the burns are very severe. One of the most marked effects is on the eyes and 1 in 14,000,000 is enough to cause conjunctivitis. The bulk of mustard gas casualties were eye cases.

The introduction of mustard gas changed the whole aspect of warfare of every kind. It produces no immediate symptoms, yet it will burn the body—inside and out—wherever there is moisture. Even in warm weather it may persist for days, and in cold weather it lingers for weeks. In the earth it remains unaffected for weeks and months, and for that time makes digging in infected ground highly dangerous.

When first used, as a defensive agent, it delayed our attacks

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of Autumn, 1917, by a fortnight. In the big German drives of 1918 mustard gas was used in the *offence* to cause casualties, break up units and generally undermine the *morale*; and during the battles themselves it was employed to block out extensive areas and neutralize strong points which the enemy did not wish to take by direct assault. One of the most noted cases of this was at Armentières, which was deluged with mustard gas, causing our immediate withdrawal. Although they themselves could not enter for more than two weeks, it enabled the Germans to take the city with practically no loss of life.

This use of toxic persistent gases is most important. It enables a commander to deny whole areas to his opponent, to contain successfully the strongest fortified posts or to effect their neutralization. Above all, it allows him to rest his attack safely on artificial flanks. He can form a defensive flank wherever he wishes, independent of troops or natural features. He is practically safe from counter-attacks at these points. He can also use the gas for barrage purposes to prevent or delay the arrival of supplies and reinforcements and, most important, he can use it for counter-battery work. For silencing artillery it is most effective. Every shell fired counts. The effect is cumulative.

Even allowing for the slow action of mustard gas, gun crews are forced to protect eyes and lungs with gas masks. This at once reduces efficiency and slows down the rate of fire. Sooner or later, however, the gun must go out of action, either because of the inability of the gunners to carry on indefinitely while wearing respirators, or because of body burns supervening.

The only course open to an army attacked in this way is swiftly to map out the bombarded areas according to the nature of the shell and deduce accordingly the line of attack; for the enemy himself is not in a position to traverse or occupy the areas bombarded by lethal persistent gas. If he were, his tactics would be entirely different. The initiative would be assured to him and his success certain if in possession of a sufficient quantity of the chemical. You see then roughly where we finished at the end of the late war. There were quick-killing gases like phosgene, used in clouds, projectors and shell. There were particulated materials like the toxic smokes—very difficult to protect against and possibly capable of penetrating the enemy's lung protection; in any case almost certain to make such protection progressively more difficult to wear. Lastly there were the persistent toxic vesicants like mustard gas.

To a certain extent these classes can be combined and will be still further combined in the future. Mustard gas, for example, if burst with a high charge and an instantaneous fuse on top of the ground, becomes very quick in its action and by virtue of the higher concentration effectively lethal. This effect is still more marked if the

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shell are shattered in the air just about a man's height from the ground.

You will gather from this summary that in some form or other gas is applicable to every phase of war. That is both its merit and its danger. It has to be guarded against. To meet gas requires above all else, understanding and discipline.

Action and reaction are equal and opposite. Sooner or later defence balances offence. But there is a lag, sometimes a big lag, before the balance is adjusted. The duration of that lag may decide a war. That is particularly so in the case of a progressive subject like chemical warfare. The cutting down of the time factor, the reduction of the margin is largely up to you. Research and production can safely be left to the specialists and the "Army behind the Army." It is to the army in the field we must look immediately to balance the enemy's tactics. In the meantime that applies especially to defence. In the future it will possibly apply equally for all arms to the offence.

Defence against gas has been proved to be based on discipline, and the discipline to be based on familiarity. Not the familiarity breeding contempt, but familiarity breeding appreciation. Make no mistake; whether we want it or not, gas has come to stay. You must accept it as affecting all military considerations, as pervading all military activity. Once that is done, gas defence discipline in a disciplined army is bound to supervene of itself.

I could give you instance after instance where our gas discipline saved lives, saved positions, saved armies. That discipline was founded on understanding, not on knowledge. There was no attempt to make every officer a chemist. Nor will there be in the future. Chemists will be attached to the staff or on the staff; but the new warfare necessitates a broader education for the regimental officer, it requires a higher level of scientific training in the Army in order that fundamental facts may be known and the specialists' conclusions appreciated and applied. That is all, but it it is a big thing.

During the war a staff officer wished to allot twice the number of men to carry gas cylinders out of the line as to carry them in. He pointed out that gas is lighter than air, and therefore the cylinders would be heavier after the discharge. I mention this in no captious spirit. The officer must have been a good staff officer to think of the difference at all; but it is indicative of the kind of thing I mean and which cannot persist as chemical warfare gradually ousts warfare of explosives from its present position.

Once the fundamentals of science become everyday thought to the military man, gas discipline will cease to be a matter of obeying instructions. It will be innate. The proper use and care of protective appliances will be automatic. Consolidation of a position against gas attacks will rank in a man's mind with consolidation

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against bombardment or direct assault. Decision as to the tenability of a gas-infected area will be local. Every officer will think " Gas " for himself.

That is what we must look forward to. It will arrive automatically if the importance of chemical warfare is grasped and the general principles of scientific thought inculcated.

As to the future, all that can be said with certainty is that chemical warfare will develop rapidly, and all the more rapidly should another big war occur in our time. Sooner or later, indeed, we shall have to answer the query—" Gas or Explosives ? "

The development will be all round—in weapons, in tactics, in material. Gas will apply to all arms. With the infantry it will probably start with rifle grenades and toxic smoke candles.

The mobility of the cavalry will be used for the swift transport and installation of cloud generators and the carriage of light mortars.

Tanks will be particularly concerned with chemical warfare, but even more in defence than offence. Gas will penetrate anywhere and your tank in the future will be rather up against it. The whole tank may have to be turned into a kind of gigantic respirator and that means making it air tight. Gas may prove to be the Achilles' heel of the tank.

At first, at any rate, the use of chemicals by the artillery will be greatly extended. Probably *all* shell will be at least partly filled with chemicals. Even where destruction is required, a double effect may be obtained by firing shell containing, say, 20 per cent. gas to 80 per cent. explosive. Consider the added effect of chemicals to a long range bombardment of villages, camps or cross roads. The possibilities are too great to be overlooked.

I would like to point out, however, that gas is fundamentally independent of heavy ordnance. An enemy with little or nothing in the way of heavy guns can still be a formidable opponent by combining skilful entrenchment with a copious supply of chemicals to be fired from the lightest of mortars, from projectors, or for use as toxic smoke. This is a point not to be overlooked.

Chemicals will be used by aeroplanes and against aeroplanes. Even in the late war the Americans devised, manufactured and filled immense bombs—receptacles to be slung under the fuselage of aeroplanes—containing one ton of mustard gas. They were intended for use against Metz, but were never needed. The prospects of this form of attack are also very great.

As regards materials and the dependent tactics even the immediate future is more difficult to forecast. After all, important as chemical warfare is, we are still in the blunderbuss stage. As I pointed out before, the possibilities of chemistry are almost infinite. From mustard gas it is no far cry to a persistent gas which does not merely

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blister in tiny amounts, but kills. It requires little imagination to suppose such a discovery already in the hands of potential opponents, but one could sit for days and use one's imagination on the effects of such a discovery without exhausting its possibilities.

Even the increased use of blistering chemicals might force men to wear special impermeable clothing, and the development of toxic smokes might force them to use oxygen breathing apparatus by making efficient filter-type respirators too difficult to breathe through. An army immobilized in this way would be at a grave disadvantage.

Purely hypothetical possibilities are unlimited. A recent writer has suggested the possibility of chemicals being discovered which would destroy the sense of equilibrium by coagulating the liquid in the internal ear. That was an imaginative picture we sometimes gossiped about during the war ; but it might be made real. An army exposed to such a gas would be unable to walk straight ; possibly unable even to stand upright. Its men would be no more use than children just learning to walk.

To follow such ideas in one's mind always seems to lead to a deadlock. It seems impossible to see farther than complete immobilization and "stale-mate." But there will be no deadlock. There never has been in the past, though increased rifle range, machine-guns and the never-ending contest between guns and fortifications have all pointed to it at the time. One side or the other will always have the advantage in tactics or material for a short time, possibly even the superiority to give them overwhelming advantage.

As long as war is possible we have to insure that such temporary or permanent advantage or such partial or complete superiority is ours and not our neighbours.

In conclusion, I have a few pictures to show you. They have been chosen either to let you visualize some of the conditions of chemical warfare or to excite in you a spirit of emulation as regards preparedness. To the latter type belong some photos of the American Chemical Warfare Arsenal at Edgewood, which I had the privilege to assist in founding.

The Americans have been very open in telling the world what they did in chemical warfare in the past. This very disclosure is significant in view of two pronouncements by eminent American soldiers :

Major-General Sibert, my friend and late chief says :—" There is no field in which the future possibilities are greater than in chemical warfare, and no field in which neglect to keep abreast of the times in research and training would be more disastrous."

Brig.-General Fries, the present Chief of the United States Chemical Warfare Service, says :—" Poisonous gas in the World War proved

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to be one of the most powerful weapons of war. For that reason alone it will never be abandoned."

From these statements, placed side by side with the American disclosures, only one conclusion can be drawn.

America is our friend and our blood relation. But we must be as well prepared as our friends and we have no wish to be dependent, even on our relatives.

What other nations which are not our friends are making equal preparations but no disclosures?

We must be prepared to follow the new road.

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SOME EXPERIENCES OF AN ENGINEER OFFICER WITH THE SALONIKA ARMY.

By COLONEL COMMANDANT G. WALKER, D.S.O.

THE experiences of an Engineer in Salonika must be a record of forlorn effort to compass the impossible with few materials; an effort sustained by the ever-present hope that with a little luck and a light heart he might be able to achieve something. In the short compass of a lecture it is difficult to do more than touch very lightly upon the various activities of an Engineer in such a country, and this must be my apology for what may seem to some to be a somewhat sketchy account of our work.

2. No account of the doings of any branch of the Army in Macedonia would be complete without a short notice of the reasons that brought a British Army into the country. Briefly they were these :—

(1) To relieve and support the Serbs in their dual struggle with Austria and Bulgaria.

(2) To deny the use of the seaboard of the Balkan Peninsula and the Isles of Greece to the Submarines of the Central Powers.

The first was necessary in order to fulfil our promises to the Serbs, the second to protect the sea route to the East through the Mediterranean. A cursory glance at a map will make this clear.

3. *Operations.*—The Salonika Campaign may be said to have commenced on the 30th September, 1915. The Bulgars had attacked the Serbs on the 29th without a declaration of war. France and England decided to assist the Serbs and landed troops at Salonika. The formations sent out in the first instance and landed on about 5th October, 1915, were :—The 10th British Div. from Gallipoli; the 122nd French Div. from Gallipoli; and the 113th French Brigade from France. The French Force was shortly strengthened to three complete Divisions and, with this Force, General Sarrail attempted what was really the impossible. The French advanced up the Vardar towards Stumica with a view to relieving the Serbs besieged at Veles, while the British took post on the Beles range near Kosterino to cover the right or eastern flank of the advance. The relief of Veles failed and the French then struck west to cut the Bulgar's line of communication, as they pursued the flying Serbs down the Babuna pass towards Prilep. This movement also failed through lack of

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Forces and the Allied troops were forced to retire southwards to their base at Salonika.

The Allied retreat was only executed after very heavy fighting, and the troops suffered terribly from cold and frostbite; the temperature, even in the valleys, registering seven degrees below zero Fahrenheit. The French retired down the Vardar valley, the British *via* Doiran and Kilindir, and reached Salonika safely. The enemy did not pursue beyond the Greek frontier, for what reason it is not quite clear, but probably because they did not desire to upset the Greek King's arrangements. Meanwhile, further reinforcements were arriving and the 22nd, 26th, 27th and 28th British Divisions from France were concentrated in and near the town of Salonika early in January, 1916. The most urgent work was then to create a defensive position for the protection of the base. The line occupied was now from the Gulf of Orfano, on the east, *via* Beshik Lake, Langaza Lake, Tumba, Laina, Balja to Naresh on the Galiko River. This area was occupied by the British 27th Division from Orfano to Langaza Lake (east end) with the 22nd, 26th, and 28th Divisions on the remainder of the line, the 10th Division being in reserve at Hortiack. The French Army continued the line from Naresh to the Vardar near Topsin. The creation of this line was pressed forward with feverish activity in spite of great difficulties as regards transport of stores, especially in the 27th Division Area. The Brigade at Stavros was supplied by sea.

The work went on until May, 1916, when it was practically completed. Indications of a move then began to appear and ultimately the Allied Army moved up or "closed" with the Bulgar on the Frontier. The French moved first to the Doiran-Vardar area. The British followed in August. The 12th Corps (22nd and 26th Divisions) relieved the French, who moved west of the Vardar. The 16th Corps (10th, 27th and 28th Divisions) moved to the line of the Struma, an interval between the two British Corps (in the Krusa Balkan) being filled by an Italian Division which had arrived. These troops were ultimately withdrawn in November, 1916, and then the whole line from the mouth of the Struma to the Vardar, a distance of about 100 miles, was held by five British Divisions and two mounted Brigades (Yeomanry).

This situation was maintained until the spring of 1917, though the line held was modified and improved by British attacks, at both Doiran and on the Struma, in September, 1916. Early in April, 1917, preparations for a general attack by the British were initiated. The main objective was the occupation of the high ridge above Doiran. The 60th British Division had arrived from France and was placed in the 12th Corps. The attack was

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designed to synchronize with one to be made by the French and Serbs near Monastir, and was in effect a dress rehearsal of the victorious attack made in September, 1918. After some delay two Divisions advanced to the attack in the neighbourhood of Doiran on 24th April, 1917. The movement " drew " all the enemy opposition.

We were under-gunned and the attack from Monastir did not materialize. The result was almost complete failure with heavy loss. The effort was repeated with fresh troops on 8th May with a similar result. After this there was no attempt at a big forward movement until the following year and the Army settled down to strengthening the position, improving communications, preparing retired lines, etc. Roumania was down and out and we felt that there was every probability of a heavy offensive against us. We were weak in numbers and riddled with disease, and the outlook was black enough. To add to our troubles the 10th and 60th Divisions were moved to Egypt, together with our two mounted Brigades, in September, 1917. This state of affairs continued until early in 1918 when the re-organized Greek Army began to materialize in strength. It gradually took over the Struma line and permitted a closer grouping of the British, who closed up to Doiran and one Division (27th) relieved the French on the right (west) bank of the Vardar.

The early part of 1918 was an anxious time owing to the trend of affairs on the western front, but finally, in September, the great attack was organized. The French and Serbs attacked from Monastir towards Prilep, while the British re-enacted their old movement of April and May, 1917, with the result that is so well known. The British attack was held up with heavy loss until the Allies gained Prilep and then the Bulgar resistance gave way. After a short pursuit and a threat to the Turks, both they and the Bulgars capitulated and the Macedonian Campaign was brought to a victorious close.

4. After this brief summary of the military operations I shall now consider how this campaign differed from that in France and Belgium, and in what particulars it was of more than ordinary interest to the Engineer. The outstanding features of Macedonia were as follows :—

(*a*) The extraordinary richness and fertility of the soil, and the real beauty of the Hill Country. The land in springtime was a garden, carpeted with flowers, from the " darting speedwell " to the Madonna lily. Nothing could have been more charming.

(*b*) The almost entire absence of communications of all sorts.

(*c*) The hideous unhealthiness of the whole area. Malaria and dysentry were the principal plagues, but cholera and other diseases were also about.

(*d*) The copious water supply except in the alluvial plains.

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(*e*) The great variation in climate between summer and winter and also between that of the hills and the plains.

All these but the first provided work for the Engineer and the first supplied him with an incentive to succeed.

5. *Communications.*—Communications are the deciding factors in most campaigns, and in Salonika they were the greatest factor of all.

Firstly, the external communications with the oversea base in England were most precarious. The sea route from England is 3,012 miles long, from Marseilles it is 1,407 miles ; both were increased in length if ships came *via* Alexandria. Salonika to Taranto is 900 miles, Salonika to Alexandria 800 miles. The result was extreme difficulty in obtaining materials and supplies of all kinds. As Salonika itself could supply nothing, the situation can easily be imagined.

Added to this the amount of shipping was so short that there was no leave, no relief except illness from the never-ending drudgery for the men. In 1917 a new route overland *via* Taranto in the south of Italy was opened (900 miles) and subsequently the sea journey was shortened by the opening of a land route to Itea on the Gulf of Corinth whence the sea journey was short and safe. All this took time and entailed enormous labour in railway and road work. The internal communications in Macedonia in January, 1916, consisted of the following :—

1. Rail, Salonika—Monastir
2. ,, ,, —Karasouli and up Vardar Valley
3. ,, ,, —Doiran and east to Constantinople
4. Road, ,, —Seres and Drama
5. ,, ,, —Monastir
6. ,, ,, —Hortiack

The railways were single lines 4 ft. 8½ in. gauge. The roads were metalled, about 12 ft. wide, with no bottom, made for light wheeled traffic. All the other routes or roads were simply field tracks, hard enough in summer to carry motors and lorries, but all almost impassable in winter for even horse vehicles.

The Seres road was the only communication worthy of the name to the Struma front, except by sea to Stavros. The Doiran front had two lines of rail and a connecting line just behind the front, but no road movement in large bodies was possible in winter. After the troops moved to the Struma in June, 1916, their supply by the Seres road was most precarious. In fact, as early as August, 1916, this route was rapidly breaking up. It was some time, I fear, before the situation was clearly realized : that is to say, realized from a curative point of view, and the road-making

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organization put on a sound footing. All sorts of road-making gear, such as rollers, stone-crushers, etc., etc., had to be imported, and meanwhile the repairs were of necessity of rather a "bow and arrow" type.

Labour and its supervision were a great difficulty. At first labour was plentiful, but labour spoke an unknown tongue. Britishers who spoke Greek or Turkish were few and far between, and my first effort on a tactical road south of Langavuk with 2,000 coolies was an awe-inspiring experience. My best ganger was a private soldier of the 1st Battalion Royal Irish who, by means of a thick stick and the language of signs, proved himself to be not only a very efficient but also very popular person with the coolies. We collected them when possible in camps, paid them three drachmas (2s. 6d.) a day and gave them free rations. At first we only employed men, but, later on, men, women and children were used. The men for quarry work, loading and unloading stone and spreading; the women for breaking stone, when no crushers were available; and the children to enliven the proceedings. Incidentally hand-broken stone wears much better in a road than stone broken in a crusher. Very large numbers of women were used in outlying parts of the country for stone-breaking and did their work well. Poor creatures, if it had not been for their rations, which they drew in part payment for their labour, they would in most cases have been starving.

I remember one day seeing a Turkish gipsy woman breaking stone with her right hand while she was holding a tiny child to her breast with her left. I pointed her out to the Sapper in charge and suggested that this procedure was neither good for the baby nor the stone-breaking. The next time I visited the gang this Sapper had a *crêche* organized under an elderly lady, who took charge of all the very small children during the working hours. The old lady sat under a tree and all the children played about round her. This action of the Sapper was typical of the attitude of the British soldier to the inhabitants. Another incident of this sort, which occurred during the great fire in Salonika, is worth recording. When the fire was at its worst at night, great crowds of refugees streamed down to the sea front for safety. They were of all ages and both sexes. While some people were principally interested in looting, the British soldiers were occupied largely in sorting out and sending these refugees away in lorries, to various places of safety. There was of necessity a good deal of confusion and some of the mothers were afraid of losing their children. The lorry drivers were, however, equal to the occasion, and arranged to tie labels, marked with numbers, round the children's necks, at the same time presenting the mothers with duplicates, so that the danger

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of a child being lost was reduced to a minimum. I did not see this, but the story filtered through up to the line where I heard it. I know, however, that my civil work-people were full of the kindness and care bestowed on the sufferers from the fire, by the British troops. I tell these tales to show that wherever he goes and whatever he does, the British private soldier always behaves as a gentleman and is the King of Goodfellows.

6. *Road Construction.*—The first bit of new road construction that was undertaken after the arrival of the British Army was, I believe, the road from Kalamaria *via* Kapudzilar and the Akukli plateau to Hortiack.

The defensive position then ran just north of the Hortiack hills with a switch or reserve line through the latter, and it was desired to make a circular route from the town to Hortiack to relieve the congestion of traffic on the old Turkish road through Urenzik and Kireckoi.

Work was commenced with military labour from 27th Division and a Brigade of infantry was camped at Kapudzilar. It was my lot to control the work. I was first told to make a road for limbers, then a road for G.S. wagons, and finally a lorry road. All this time work was in progress and I was much troubled as to the "ruling gradient."

The ground was steep and I was in doubt as to what the grade should be. However, I settled it by making it as flat as I could and leaving the rest to luck. Time pressed, and there was none for speculation. It worked out to 1 in 12, and there was a lot of it at that grade. However, when finished, lorries and all sorts of motor traffic ran merrily up and down, especially down, until the end of the chapter. As a matter of fact, I think what saved it was that I kept the curves big and had no sharp corners. The grades were laid out with a pendulum clinometer (Indian pattern) from the Field Co. equipment. It is a rough instrument but accurate enough and, when you are used to it, a quick one to work with. One of my assistants, a young Scottish Railway Engineer, who was accustomed to theodolites and chains, was much disturbed at having to use the instrument. He could not work with it at all at first, but with practice became an expert, and admitted finally that it was all right. I had an amusing experience with the General Staff during the time we were on this road. One night I got news that a whole Brigade of four strong Battalions was to report to me for work next morning. I had nothing prepared for them, no tools and, in fact, not sufficient road surveyed, so I wired back to send them in a fortnight. This shocked the Staff but I carried my point and proved to them that road-making was not quite the same thing as the magic of a harlequin. I imagine that in a

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fortnight something else had been found more urgent for this Brigade to do, but I can't remember this.

This brings out an important point. Never trust your eye for grades on a steep hill road. If you do you will certainly be sold. With practice your eye will spot the probable line, but that line must be tested with an instrument of some sort. Grading is most important on steep ground, as all vehicles, whether horsed or mechanical, must have places on which they can " take a blow " on a long ascent.

Our next venture was a tactical road. The 10th Division made a very good but steep road from Hortiack to Azrumeri. It was well graded and made, but was not taken over the easiest line, owing to lack of time in reconnaissance. The Staff gave the starting and terminal points. The Engineers took the shortest route, a grave error, as it was not the most economical in time of construction, quite apart from monetary considerations. We prolonged the road from Azrumeri to Jerekaru, just behind our trenches, and then carried it on behind them across the Zaglaveri plateau to Ilanli, whence a mule track ran down to Gomenic. This road was an essential lateral communication to the defence line. It was fine weather and there was no time to metal it throughout, nor labour nor material either. We just laid it out, ditched it, 30 ft. between the ditches, bridged it and cut and metalled the approaches to the big *nullahs*. They were two in number, about 100 ft. deep. This made it a safe communication, for in dry weather vehicles could move off it, and in wet the ditches and drains kept the land dry. After the grading, drainage is the next essential for hill roads, far more important than metalling. If a road is wet you can do nothing with it. This road cost about £10,000 a mile. My civil engineers were aghast at this, but it could not be helped, as we had little transport except donkeys and men, and very few carts.

Cost what it might, we had to go on, as the completion was vital to the defensive line, as can readily be seen by reference to the map. Many times afterwards I found that in extremity the simple ditching and draining of a marked track, on the plain behind Doiran, saved the transport situation during operations. Macedonia, though very dry in summer, is subject to very violent thunder storms accompanied by torrential rain, and it is during these crises that the ditches and drains were so useful, as they kept the tracks dry and helped them to dry out and harden when the cataclysm was over, as it usually was in an hour or two. After the Army moved forward to the Struma and Doiran the question of roads was critical. In fact, it was the one problem. The only communication to the Struma line was the Seres road. It ran over steep ground, precipitous in places, especially at the Struma end. It was metalled about 12 ft. wide

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and there was no soleing. It was an old Turkish road and followed an ancient route. Length about 50 miles. The effect of the motor traffic, for the supply of everything to three Divisions, is more easily imagined than described. In fact, the road practically broke down. So bad was it that the lorry drivers used to be sea-sick while driving along it. It was a desperate proposition. The situation had been anticipated to a certain extent in the summer of 1916 and a certain number of quarries had been opened along the road. R.E. Co.'s also had been stationed at intervals to control the maintenance by civil labour and keep the road alive. This, however, was not enough and the road got steadily worse until, in the end, the nettle had to be firmly grasped and the resolution taken to remake the road and put in soleing. It was an immense work. A great road department was organized under L. of C. control. Rollers, stone-crushers, etc., etc., were collected, labour was swept in from all quarters and eventually the road was remade and the communication to the 16th Corps preserved. I have no time to give small details more than to say that the success of the work depended on the most minute care being taken in organization of labour, development of quarries, organization of transport and of material, and, finally, the organization of the communication transport, to divert it when the ground permitted and to keep it off the road. The work was practically completed in the summer of 1917, but the maintenance work continued always. It was calculated that the number of vehicles passing on the most used parts of this road was 5,000 per day, and that with this load the road, as remade, required retopping once every eight months.

The branch railway line from Salamanli to Guvesne was put in to save the first 17 miles of the road as much as possible and to relieve the congestion on that portion which ran through the Lembet plain. An advanced supply dump was placed at Guvesne and here also the Commander-in-Chief had his advanced Headquarters.

To turn now to the Doiran front. To this there was no road at all and in the winter it was almost impossible to get up except by rail, of which fortunately there were two lines. L. of C. in the end of 1916, or early in 1917, commenced the prolongation of the Salonika–Naresh road up the valley of the Galiko to Sarigol. A bit of good road existed from Sarigol to Kukus and the 12th Corps had to prolong this to Janes (their Headquarters) and thence to their line at Cugunci. This work began in the autumn of 1916 and was finished about May, 1917. There are two points to be noted in respect of its execution.

(1) The road from Kukus to Janes was made only 12 ft. wide, a very grave mistake. It did not allow of easy passing, and

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vehicles drove into the drains and choked them, incidentally getting ditched themselves. It also meant that the 12 ft. had to bear both up and down traffic and consequently wore badly. No road should ever be metalled less than 15 ft. wide for military traffic.

(2) The route selected for the road beyond Janes was not the shortest. The road was taken about six or seven miles out of its way in order to pass a good quarry near Kirec. This diversion was useful afterwards, but I doubt of its being economical, as it entailed the negotiation of some very low-lying wet land. However, a choice had to be made and was made as stated. Such questions have always to be considered in making roads. Another road which gave a good deal of trouble was that between Kukus and Snevce-Karamudli. It had been laid out by the Italians, 12 ft. wide between the ditches—on a surface grade. The grading and bridging were well done. The road was too narrow and, when we took it over at the end of 1916, it was *in extremis*. However, we got it right for light traffic by draining it properly and finally metalling it, and in six months' time it was a good road for high-speed motor traffic.

To summarize the work, the following were the main metalled roads constructed :—

Seres road, 50 miles.
Kapudzilar road, 10 miles.
Sarigol road, 24 miles.
Sarigol-Cugunci road, 17 miles.
Karasuli road, 20 miles.
Bralo-Itea (Gulf of Corinth) road, 20 miles.

Besides these, innumerable by-roads were drained, repaired and maintained. All the work was done under R.E. supervision, the actual labour being principally native. Some labour Battalions were, however, employed. These roads were all in the L. of C. or Corps areas, the Divisions being responsible for roads and tracks close up to the line, and they had their hands pretty full. When the advance came, the experience gained during the first three years was invaluable to the R.E. when they had to tackle the question of repairs to roads and bridges destroyed by the enemy during their retreat.

One word should be said about quarries. The speed with which roads can be made depends entirely on the supply of stone. Quarries must be located at convenient distances along the route, the stone must be good and the development of the quarry must be such as to facilitate rapid output. Tools available for quarrying stone are of great importance. At first we only had jumpers and

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boring bars, but later, when power drills were available, the work was much expedited. The following was found to be the average output on road work :—

Soleing—8 square metres per man in 9 hours.

Metalling—12 square metres per man in 9 hours.

Rolling.—80 metres (half width, per roller in 24 hours. Roller worked continuously (by artificial light at night) with reliefs of men.

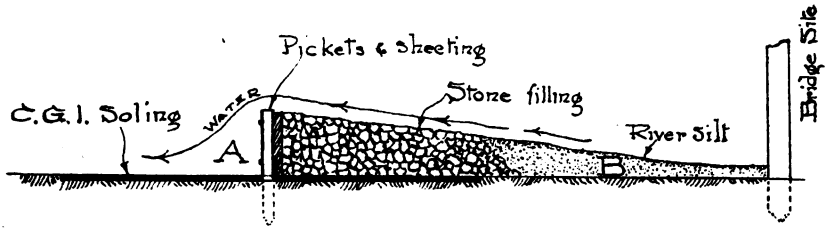
A few hints as regards methods which were found useful in Macedonia are worth recording.

(*a*) *Drainage.*—In alluvial plains try and keep away from the absolutely lowest levels in locating the line of road, so that drainage may be possible. A cross-section of the land on which the location is made should be at least 1/20 if possible—at any rate, avoid absolutely flat ground.

(*b*) *Cutting and Banking on Hill Sides.*—Always cut out the whole of the road width ; don't build on made ground.

(*c*) *Protection of River Crossings, Causeways, Bridges, etc., from Scour.*—Any obstruction placed in a river, even bridge piers, is liable to raise the level, increase the velocity and produce scour. The place to protect from scour is below the object to be protected.

The sketch below shows a good form of "field" protection for road crossings and bridge sites. It is really a water-tight dam of simple



construction which raises the level of the river below the site, catches the silt at B and stops the scour. A will also gradually silt up. A road crossing made as above has stood a 3-ft. flood for 24 hours. Care must be taken that this dam is taken across to above flood level on the banks, otherwise its ends will be cut out. This system is based on work done in South Africa by Colonel Waghorn (then Captain), R.E. Similar dams can be used as groins for altering the course of a stream to prevent its cutting too much into a bend. Groins which we called "sausages" were also used with effect in order to keep streams in flat land to their course and prevent them breaking out and "deltaing." These "sausages" were made of lengths of wire

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net filled with stone and then sewn up. Placed diagonally *inwards* at the sides of a stream and pointing down stream, they keep the scour in the centre of the channel and by thus dispersing it, prevent breaks-out.

My remarks upon road-making would be incomplete without reference to the loads which M.T. traffic of the British Army bring upon them. The normal M.T. vehicle for transport work is the 3-ton lorry. This means a total moving load of about 10 tons on 4 wheels. The pace generally is 12–16 miles an hour and the result on a macadamized road is lamentable. It is bad enough on a good road, but on badly constructed, soft roads this traffic very soon becomes impossible. In Salonika the Italians had a 30-cwt. Fiat lorry which was immeasurably superior to our 3-ton vehicle for the purpose required. This 30-cwt. lorry, even if it had to do double journeys to do the work, was much less destructive to the roads, and on the country tracks it could go where the 3-tonner dared not.

The lesson is that, when operations in a wild, roadless area commence, a light motor vehicle is essential. Light railways were in some cases (Struma) used with mule haulage to help the roads. The 60-cm. was quickly laid and it was found that two mules would haul $3\frac{1}{2}$ tons over grades of 1 in 100. That is about ten times what they would haul on a road. These tramways were subsequently in some cases converted into locomotive roads, but the light rails had to be replaced, by 20-lb. rails on 5-ft. sleepers, to make this satisfactory.

RAILWAYS.

7. As previously stated, there were three main lines of rail, of standard gauge, in existence when the Allies occupied Salonika.

(1) Line to Monastir.
(2) Line to Belgrade *via* Karasouli and Uskub.
(3) Line to Constantinople *via* Kilindir, Seres and Drama.
(4) Link between Karasouli and Kilindir.

The link between the Monastir line at Plati and Papadouli on the Athens line was not completed until early in 1916, so that there was no through communication between Salonika and Athens when the Allies landed.

Of the above (2), (3) and (4) served the British Corps on the Doiran–Vardar front, with main railheads at Janes and Karasouli. Trains were run at night, however, on the link-line between Karasouli and Kilindir. At first all the lines were under Greek administration, but ultimately, in June, 1916, they were forcibly taken over by an Anglo-French Commission; the rolling stock being divided in proportion to the mileage worked by each nation. Rolling stock was at first most inadequate, and to make up

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the deficiency the British alone imported 30 engines and 2,000 wagons. The following figures show the growth of traffic between 1916 and 1918 :—

State, October, 1916. (Allied Armies).—
Locos, 121 ; wagons, 1,230.
State, December, 1917. (Allied Armies).—
Locos, 172 ; wagons, 2,806 ; coaches, 232.
State, December, 1918. (British Only).—
Locos, 70 ; wagons, 1,813 ; coaches, 60.

The rolling stock had no continuous brakes. Engines had steam-brakes, and brake-wagons were distributed through the trains. An allowance of one brake-vehicle to 15 loaded trucks was allowed on the level, and one to five loaded trucks on grades of 1 in 50. At first, the utmost confusion existed at the port and the stores had to be transported by lorry some six kilometres to the dumps and railing points. The first railway work was to put this right. Dudular was made the main distributing depôt and was connected by rail with the piers and with the advanced parks at Lembet. Besides this an immense amount of work was carried out in putting in sidings in the dumps and store depôts. Later on, advanced depôts were opened at Guvesne at the 26th kilo on the Seres road, which had been connected up by a branch line to Salamanli on the Doiran line. This entailed the building of a piled bridge over the Galiko river, but otherwise the work presented no engineering difficulties.

The following figures show the growth of traffic over the standard gauge lines between 1917 and 1918 :—

	Men.	*Stores.* (tons)
Quarter ending Sept., 1917 ...	60,000 ...	90,000
,, ,, March, 1918 ...	140,000 ...	160,000
,, ,, Sept., 1918 ...	300,000 ...	145,000

After the organization was put in order the main and constant difficulties were shortage of rolling stock and ultimately shortage of fuel and constant shortage of personnel owing to disease. Indeed, at the end of the summer of 1918, the organization was on the point of breaking down for want of fuel and of men.

Light Railways.

Janes–Kalinova Line.—When the 12th British Corps moved to the Doiran–Vardar front in August, 1916, its railhead was established at Janes, whence the troops were supplied by road vehicles. This served in the fine wather, but, in view of the fact that there were no roads in winter and the Kilindir and Karasouli line could not then

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be used, it was decided to run a 60-cm. line from Janes to Kalinova. There were no great practical difficulties on the route, which was 12 miles long, and the work was completed in three months. It was then operated by the local Divisional C.R.E. for a long time. It was of the greatest value that winter; and troops, stores and hospital patients (in special trucks) were carried.

This was the first up-country light line made by the British.

Sarigol–Snevce Line.—The French had previously constructed a 60-cm. line from Sarigol to Snevce (18 miles). It was roughly laid with light rails and was for a long time a constant source of trouble, owing to the engines constantly breaking down. It was completely relaid and largely relined by the British, and, with better engines, proved invaluable for supply of troops in the Krusa Balkan. This line was ultimately prolonged to Karamudli, about three miles north of Snevce.

Stavros–Tashli Line.—When the British 16th Corps occupied the Struma in July, 1916, the question of supply at the mouth of that river was an important one. Supply by sea was precarious because of the exposed situation and absence of landing facilities. Piers existed at Stavros and it was decided to run a 60-cm. line from thence round the coast to Tashli Derbend, a distance of 10 miles. This was done and, by February, 1917, it had been extended to Chai Aghizi.

This line ran along a perfectly flat sea-shore and was an easy proposition.

Guvezne–Stavros Line.—In 1917, owing to the difficulties arising from the submarine menace, it was decided to run a 60-cm. line from Guvezne to Stavros *via* the lakes Langaza and Beshik. A standard-gauge line was first thought of, but this project was abandoned. The standard-gauge was indeed taken from Guvezne to Sarakli and thence 61 miles of single 60-cm. line was run into Stavros. The survey started in October, 1917, and the line was opened in April, 1918.

Light lines were also constructed at :—

(1) Dranista Mine, 17 miles.
(2) Gramatna–Rajanova, to supply the Krusa Balkan, 24 miles.
(3) Likovan–Mirova (horse).
(4) Kôpriva–Gudeli (horse and petrol tractor).

The last two lines were constructed by the Divisions in the areas. The rolling stock for the 60-cm. lines consisted of locos of Hudson 0.6.0 type and Baldwin 4-6-0 type, besides petrol tractors. The wagons were of high capacity, carrying 10 tons. The Baldwin engines would haul 45 tons over a three per cent. grade.

After the Armistice, the railway situation altered and it became necessary to open up the country east of the Struma. In order to do this, the Demi Hissar bridge over the Struma on the Constantinople

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line was rebuilt (it had been blown up by the French in 1916), and the line through Seres and Drama was repaired, the work being completed and communication opened with Constantinople in January, 1919. Besides this 60-cm. lines were laid :—

(1) From Vetrina to Radomir.
(2) From the Stavros line across the Struma at Neohori to Angista.

Demi Hissar (Vetrina) Bridge.

Reconstruction.—This bridge, which had been blown up by the Allies in 1916, had never been repaired, as it was under gun-fire from both Armies.

The bridge consisted of six spans of steel girders (each 100 ft. long) on masonry piers. It was built on a curve of 984-ft. radius. The road bridge just below had not been destroyed and was utilized both for the reconstruction and getting troops across the river, a 60-cm. line being laid over it.

The condition of the Railway bridge was as follows :—

West abutment intact. No. 1 span, blown down but repairable ; No. 1 pier, repairable ; No. 2 span, repairable ; No. 3 span, destroyed ; No. 3 pier, intact ; No. 4 span, repairable, the bottom boom was broken ; No. 4 pier, completely destroyed to foundations; No. 5 span, destroyed ; No. 5 pier, intact ; No. 6 span, destroyed ; east abutment, intact.

The method adopted was to jack up Nos. 1 and 2 spans with 20-ton jacks on cribbing, repair and reseat them so as to get at No. 3 span. This girder was cut up with explosives and removed. It was replaced with trestling set on piles. No. 4 span was treated in the same way as Nos. 1 and 2, and Nos. 5 and 6 in the same way as No. 3. No. 4 pier presented some difficulty as it was cut down below water level and a coffer dam had to be constructed round it, to make a new concrete pier.

The work started on 29th October, 1918, and was completed by the 18th January, 1919. The number of man hours taken in the reconstruction was 16,203 and the cost was £6,664.

A good deal of difficulty was experienced in breaking up the destroyed girders, as they were buried in the sand rather deeply and had to be completely removed to make room for the piling. Another difficulty was the lack of experienced men and adequate gear at first. The jib crane used would lift only about seven tons.

Two points are worth notice in the reconstructed bridge :—

(1) The original super-elevation of the rails had been $4\frac{1}{4}$ in. for a speed of 40 miles per hour. This was reduced to 2 in. for a

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speed of 16 miles per hour, and this was given in the design of the wooden trestles (*vide Plates* I. and II.).

(2) When the bridge was destroyed, all the expansion rollers were lost in the river. As the temperature on the Struma can be as much as 106 F. *in the shade*, this was a serious matter. The difficulty was overcome by carefully buffing the bearing-plates of the replaced girders and coating them with graphite, which, it was thought, would serve for the time being.

(*To be continued.*)

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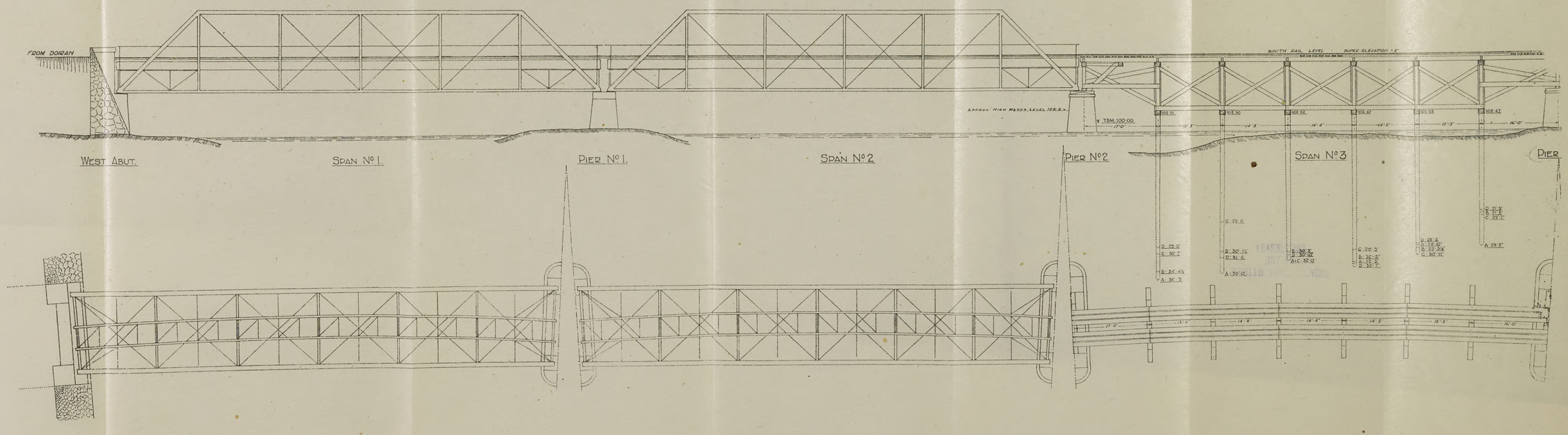
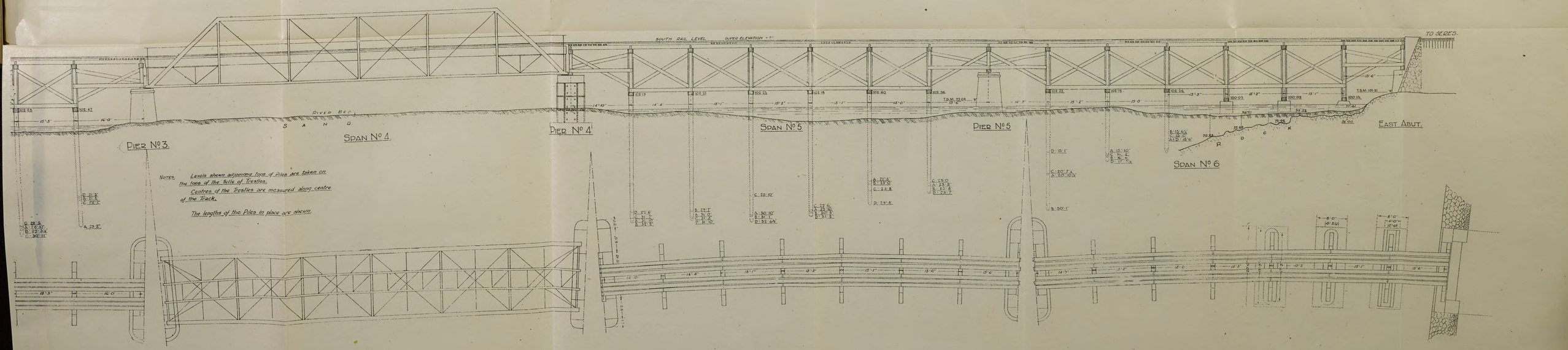
RE-CONSTRUCTION OF VETRINA BRIDGE.

GENERAL PLAN, SHEWING BRIDGE AS RE-CONSTRUCTED.





PLAN — TRESTLE SHEWING ARRANGEMENT OF STRINGERS. — STEELWORK · SPANS 1-2 & 4 SHEWING DECKING REMOVED.

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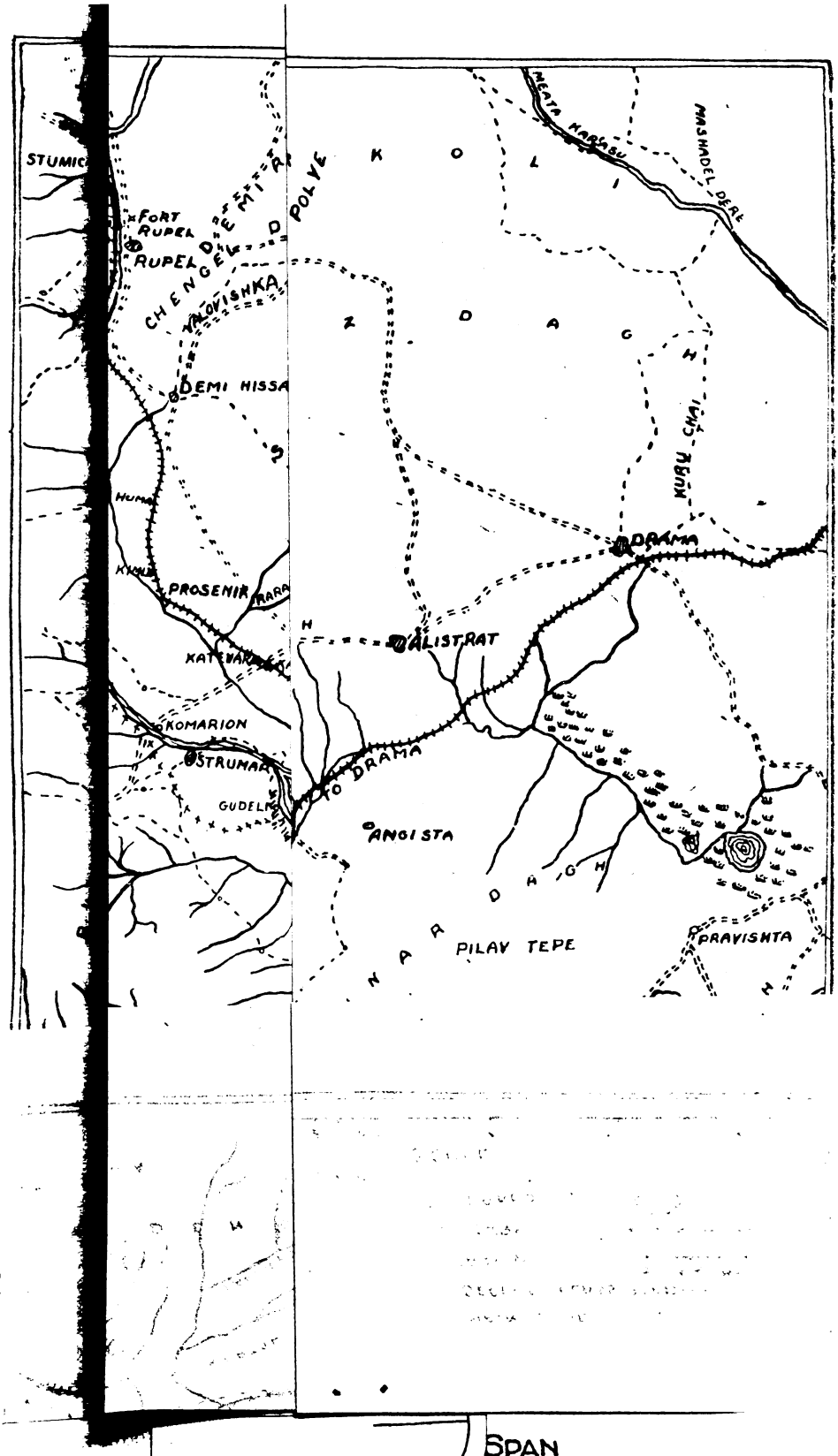

SPAN

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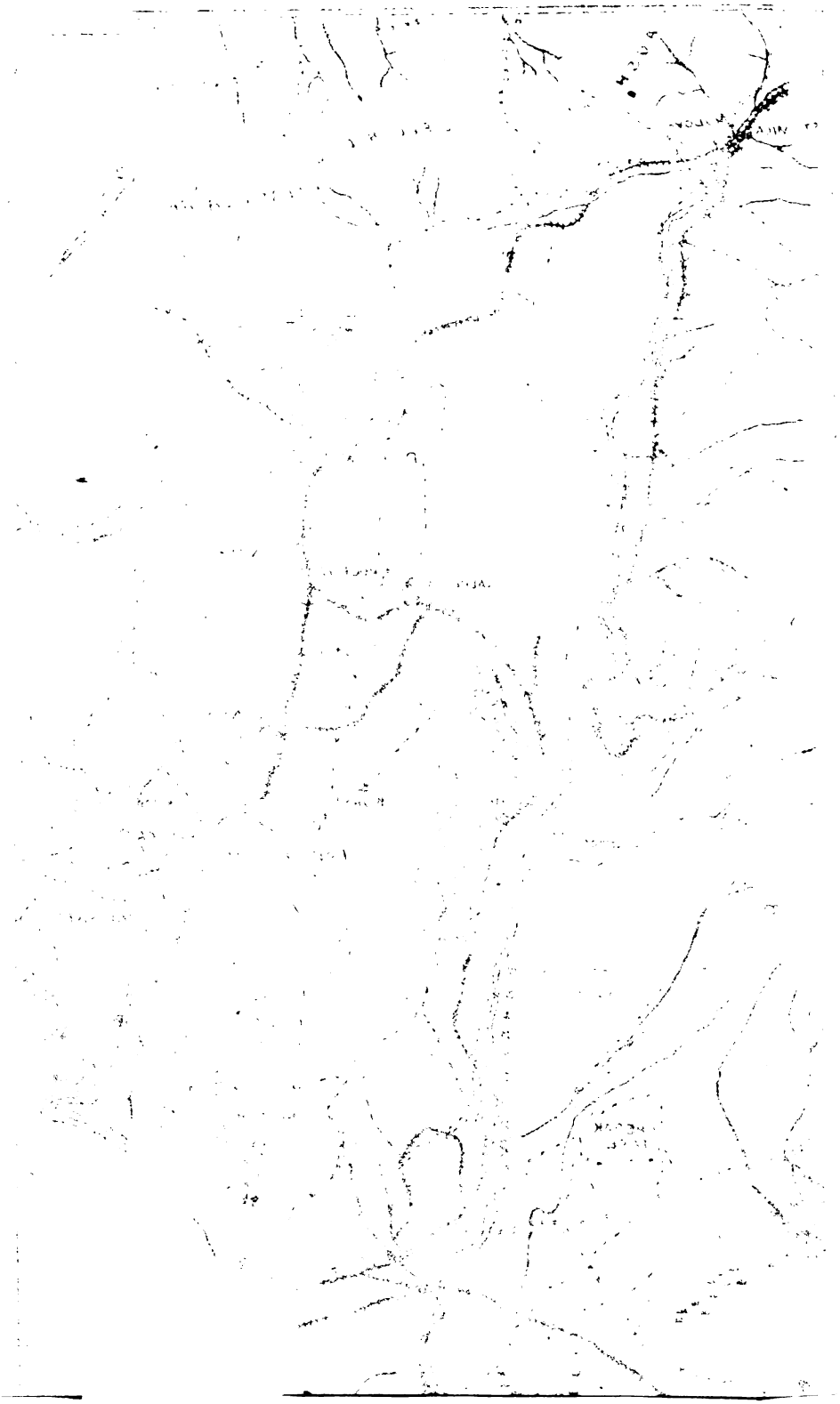

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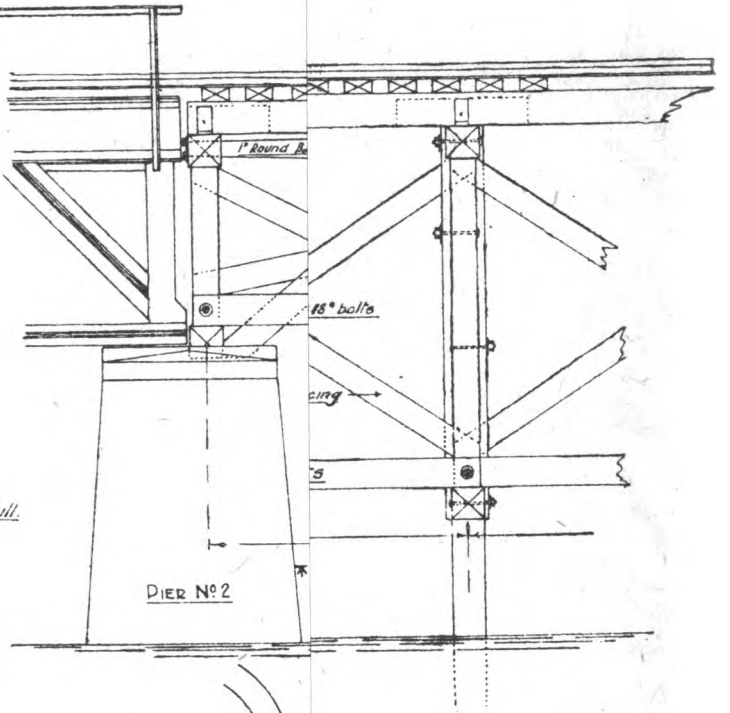
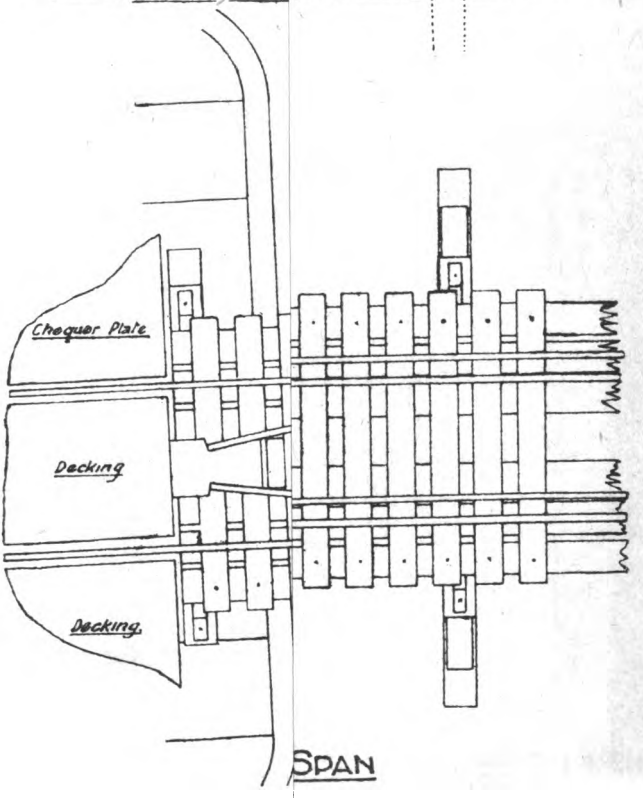
OF TRESTLE WORK.





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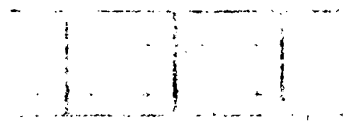

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COLONEL KENT'S PATENT SYSTEM OF HOUSE CONSTRUCTION.

By COLONEL H. V. KENT, C.B., M.I.C.E.

THIS system was evolved in 1919 to meet the Housing Problem, by reducing the cost of building and the time of erection by means of eliminating most of the skilled labour usually employed on the walls.

The writer gained much experience during the first year of the War, while he was A.D.F.W. for the Barrack Branch, in various systems of construction, temporary, semi-permanent and permanent, and after he retired he patented the "Kent" system, which is described in this article, and he claims that it is the most economical, most rapid, and most simple system in present practice, and that it gives the strongest, driest and warmest house on the market.

The system is based on the familiar "Pier and Panel" principle, the piers being of reinforced concrete, anchored into the foundations, and the panels consisting of long thin slabs of concrete, or other suitable material, which bridge the spaces between the piers.

The piers and slabs are pre-cast; the former have bolts cast horizontally in them, projecting inwards, and to these bolts the slabs, door-frames and window-frames are secured by nuts, by unskilled labour in a very short time.

In an ordinary small house the piers are set up at 4 ft. 6 in. intervals, and the bolts are set at 18-in. vertical intervals, the slabs being 18 in. high. In a dwelling house there are two skins of slabs, each 2 in. thick, with an air space of 5 in., which is practically continuous both horizontally and vertically all round the house, for the piers do not block more than 2½ in. of the air-space, leaving 2½ in. clear.

The outer slabs are secured against the shoulders of the piers by means of saddle blocks of hard wood or woodcrete, which are threaded on the bolts and pressed by nuts against the vertical edges of the slabs. *Figures* 1 and 2 show horizontal sections of pillars and slabs, but the metal stirrup shown in *Fig.* 1 has in later designs been replaced by the saddle block. *Fig.* 2 shows the saddle block, and it also shows how the outer slabs can be rebated to conceal the piers if it is not desired that they should show on the face of the wall. An alternative method of bolt with cotter-pin is also shown in *Fig.* 2.

The inner slabs are placed against the faces of the saddle blocks (which are 5 in. deep) and are secured there by nuts on the bolts or by the cotter-pins. The nuts will usually be countersunk, the corners of the inner slabs being rebated to one inch, and the inner face of the wall is then plastered to a flush surface. But where it is desired to get at the air-space, for instance in the scullery, where waterpipes, etc., will be led off inside the walls to the upper floors,

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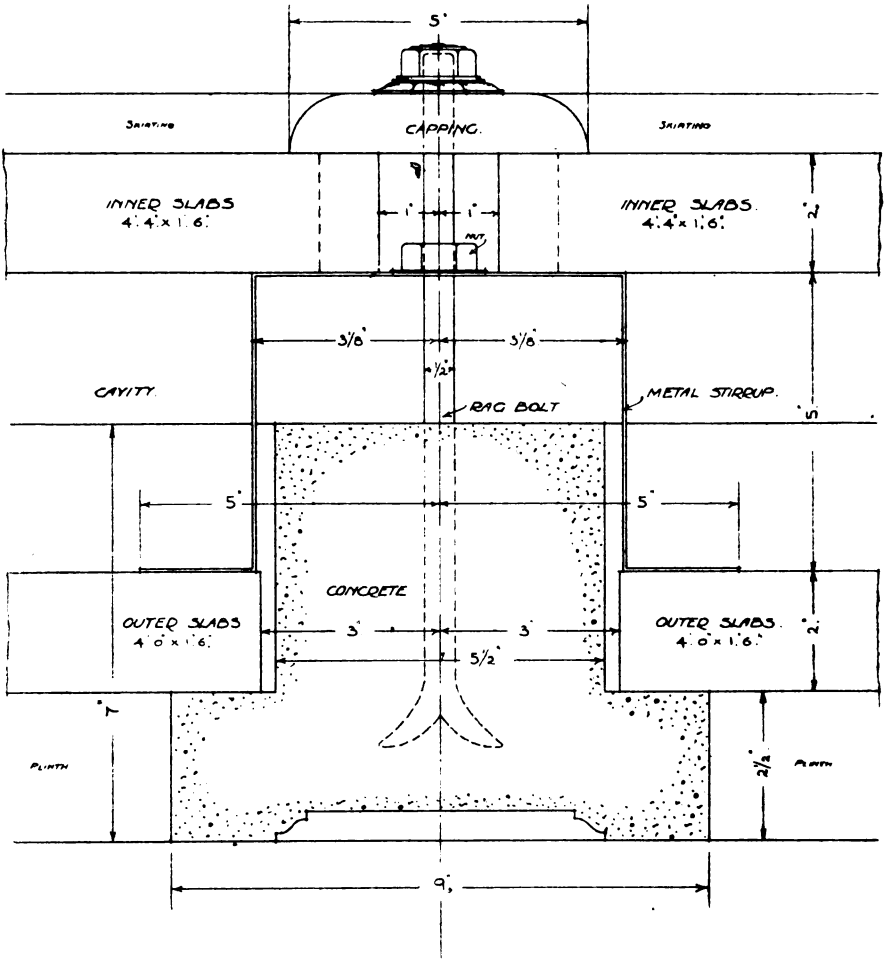

PLAN OF INTERMEDIATE PIERS.

FIG. 1.

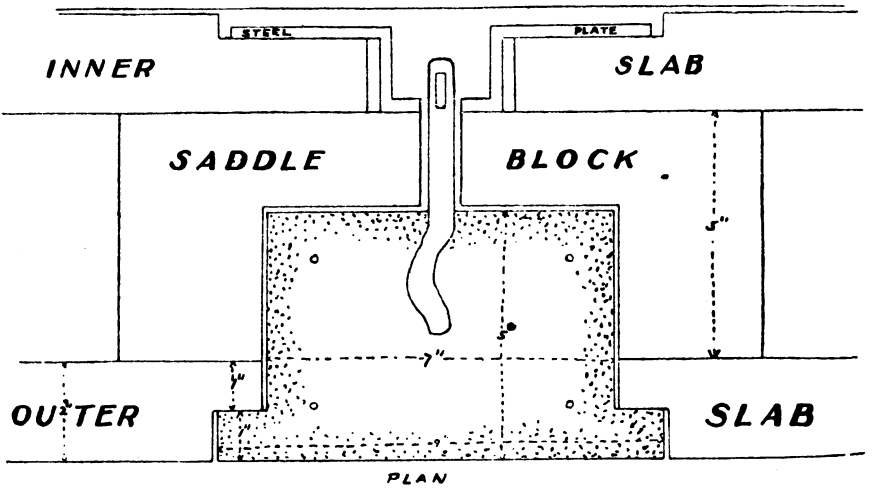

FIG. 2.—*Showing Method of Securing Slabs by a Cotter Pin, and Rebating the Outer Slabs to conceal the Columns.*

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etc., the bolts will project beyond the inner face of the slabs and these will be secured by means of vertical capping with ornamental nuts, showing on the face of the wall (as shown in *Fig.* 1), which will present a panelled appearance.

The air-space can be utilized for housing all the service pipes out of sight, *i.e.*, for gas, water, electricity, etc., and a hot pipe can be run right round the house inside the wall so as to give a warm air jacket round the entire house. In a block of barracks, or even in a village of detached cottages, built on this system, every house can be " mural heated " in this way from a central Refuse Destructor, super-heated air or steam at over 1000° Fahr. being laid on like gas or water, and in the same way a constant supply of hot water will also be available by using jacketed coppers, without lighting a fire in any house. Fireplaces and chimneys can thus be dispensed with, except where required for cooking, and where gas or electricity is available there need be none of these expensive items.

In a tropical climate it will be possible to drive refrigerated air into the walls, and the resulting temperature inside the buildings, in a hospital, say, should be perceptably lowered, especially if a hollow roof is cooled in the same manner.

A door-frame takes the place of five slabs, and a window frame takes the place of three slabs. The windows can be metal casements, or the ordinary wooden sash-frames can be used if preferred. Small windows for lavatories, larders, etc., can be fitted into the middle of a bay, taking up two slabs in height.

The upper floors can be laid on horizontal reinforced concrete slabs, bridging across reinforced concrete floor beams, which will rest on corbels pre-cast on the piers ; and a jointless $\frac{3}{4}$-in. floor of " Woodcrete " can be laid over the slabs, with rounded-up corners at the walls in lieu of a skirting board, so that there is no place where dust can lodge. Futher details and dimensions can be seen from the annexed plan and elevation.

In carrying out the work the first operation after clearing the ground is to get in the foundations, and as all the weight is borne on the columns their footings only need be considered. Quite a small trench is all that is required for the plinth course between the columns. Any good carpenter can make the moulds for the piers and slabs, but it is necessary that great care should be taken to space the bolts accurately and to fix them truly at right-angles ; the reinforcing rods must also be fixed correctly. The columns can be cast flat at right-angles to the sides of the house, and pockets should be left in the concrete foundations, as shown in *Fig.* 3 for the projecting rods to dip into, the gaps in the plinth course being just wide enough to take the 5-in. width of the columns. The latter can be up-ended by hand, with the assistance of small sheer legs, till they are vertical. They should then be guyed and set true with a plumb-bob, and the pocket filled in with a rich " super-cement " grout.

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The slabs can be made of a sawdust composition such as "woodcrete," which possesses advantages over concrete in being damp-proof, vermin-proof, non-conducting and fire-resisting, while it can

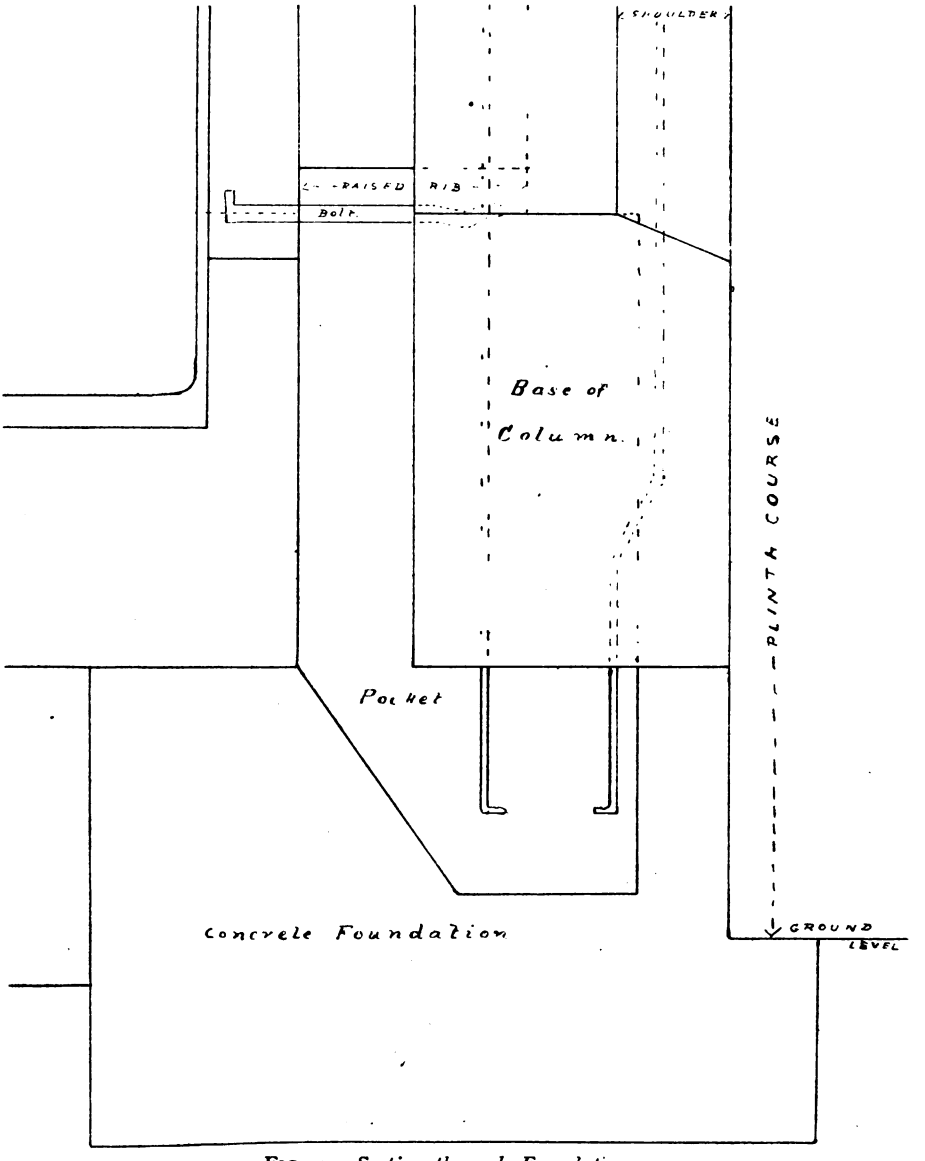

FIG. 3.—*Section through Foundations*

be moulded to take the finest edges, and it can be nailed, screwed, and even sawn. It is also a good material for "jointless" floors, curbs and stairs, and by its use practically all woodwork can be banished from the house, except in doors, cupboards, etc. A small building of "woodcrete" constructed on the "Kent" system can be seen at Bateman's Concrete Works, Hyde Lane, Battersea.

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When the columns are " set " the outer slabs and window-frames and door-frames are set in position and nutted up. This operation is very simple and should not take more than a few hours for a whole house. A simple derrick, travelling on a truck, can be rigged up to hoist the upper slabs into position, and to lay the floor beams on the corbels where a concrete floor is used. No mortar or grout is required between the horizontal edges of the slabs, but they can be tongued and grooved, and no rough casting outside is required.

The laying of the reinforced floor slabs on the beams is a very simple matter. They also can be tongued and grooved, but this is not essential. If a ceiling is decided on, wooden fillets should be cast in the under side of the beams to make it fast to. Asbestos sheets or " S.X. Board " can be used for this.

The service pipes can be laid along the saddle blocks, and finally the inner slabs can be fixed in position and a thin coat of plaster applied to the faces of those walls where the nuts are countersunk. In climates exposed to extreme heat or cold double windows are recommended, and the window boards can be perforated to allow the hot (or cold) air to get between the windows.

Partition walls can be taken off any part of the outer walls by making slots, 3 in. wide, down the slabs, and they can also be made on the same principle of 3-in. breeze or woodcrete slabs, plastered on both sides, making 4-in. solid walls.

The system will lend itself to almost any style of architecture, for the form of the piers can be varied in many ways, moulds being easily made to produce round or square columns, plain, or fluted, or panelled, with pediments and capitals, or the columns can be flush with the face of the wall, as shown in *Fig.* 2.

An effective way of treating the slabs is to cast them with V cuts to represent masonry blocks, when it will be difficult to see where the joints in the slabs occur. Rock-faced slabs can be easily made, and a " vermiculated " appearance can be produced by picking out the surface after it has set.

The first " Kent " house was put up by the War Office in 1920 for the caretaker of the Havengore bridge on the artillery ranges at Shoeburyness; it is in plan a square of 5 bays on each side, measuring 23 ft. 6 in. by 23 ft. 6 in. It has three bedrooms, a bathroom, parlour, living-room and kitchen. It contains about 14,000 cubic feet, and cost £858, but access to the site was frequently interrupted by artillery firing. The War Office report that, had it been built under normal conditions, four men, three of them unskilled labourers, could have erected it in six weeks at a cost of under a shilling a foot cube.

The M.F.W. who put it up went so far as to say that in his opinion the cost per foot on a big job, where there is repetition work, should not exceed sixpence. Considering that prices at the beginning of 1920 were at top notch (2s. a foot cube, and more, in many cases),

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and that the house was rough-cast outside (an unnecessary expense), it is not claiming too much to say that the price to-day ought not to be more than ninepence a foot cube and the time for erection should be much shorter than it is on most systems. It is one of the chief advantages claimed for this system that the labour bill does not have time to mount up.

The occupants of this house say that it is drier and warmer than the brick houses they have lived in before, and although it is constantly exposed to the blast of the heaviest guns, they have never noticed the house to shake; this is remarkable testimony to the rigidity of the structure. A pair of "Kent" houses are to be put up at Welwyn for the *Daily Mail* Model Village Exhibition in March, 1922, and another, of 26,000 cubic feet, is shortly to be built at Wimbledon, the cost of which should not exceed £1,000. The Belgian Government has ordered four houses to be built on this system near Brussels, in order to compare them with a number of others of various British, French and Belgian systems.

To make a very lasting job the piers should be made with "supercement," as then no rusting of the steel rods inside can take place, as no damp can penetrate such concrete. As the entire weight of the upper portion of the house is carried on the piers, and none on the slabs, the latter can be made of breeze, or "woodcrete," or chalk concrete, for they are subjected to no strains beyond wind pressure. The piers can be cast in one length of two storeys, or even three, and if they are cast on the site there is little trouble in up-ending them into position in one operation.

As all the units are pre-cast, and no mortar is required, there need be no stoppage of work in frosty weather, so that there should be no difficulty in completing a 25,000 cubic feet house in a little over a month, with 90 per cent of unskilled labour.

In a large building the "unit bay" will be naturally wider than 4 ft. 6 in.; the piers will be correspondingly heavier, and the slabs can be made deeper, for lifting-tackle will be available.

Where "mural heating" is applied on a large scale and fireplaces are omitted, it will be necessary to make adequate arrangements for ventilating the rooms, and this can be done by letting in "hit-and-miss" gratings in the panels of the walls at the top and bottom, and arranging for fresh-air inlets through the outer slabs.

An unusual feature in these houses is that if it is desired to alter the position of a window, or to add a new one, it is a simple matter to take out three pairs of slabs and put in a window-frame. In fact, the whole house can be taken to pieces and packed up and re-erected elsewhere at very little expense beyond the cost of transport. All those who are interested in the system, or wish to know details as to royalties, etc., are invited to communicate with the writer at 19, Hanover Square, W. 1.

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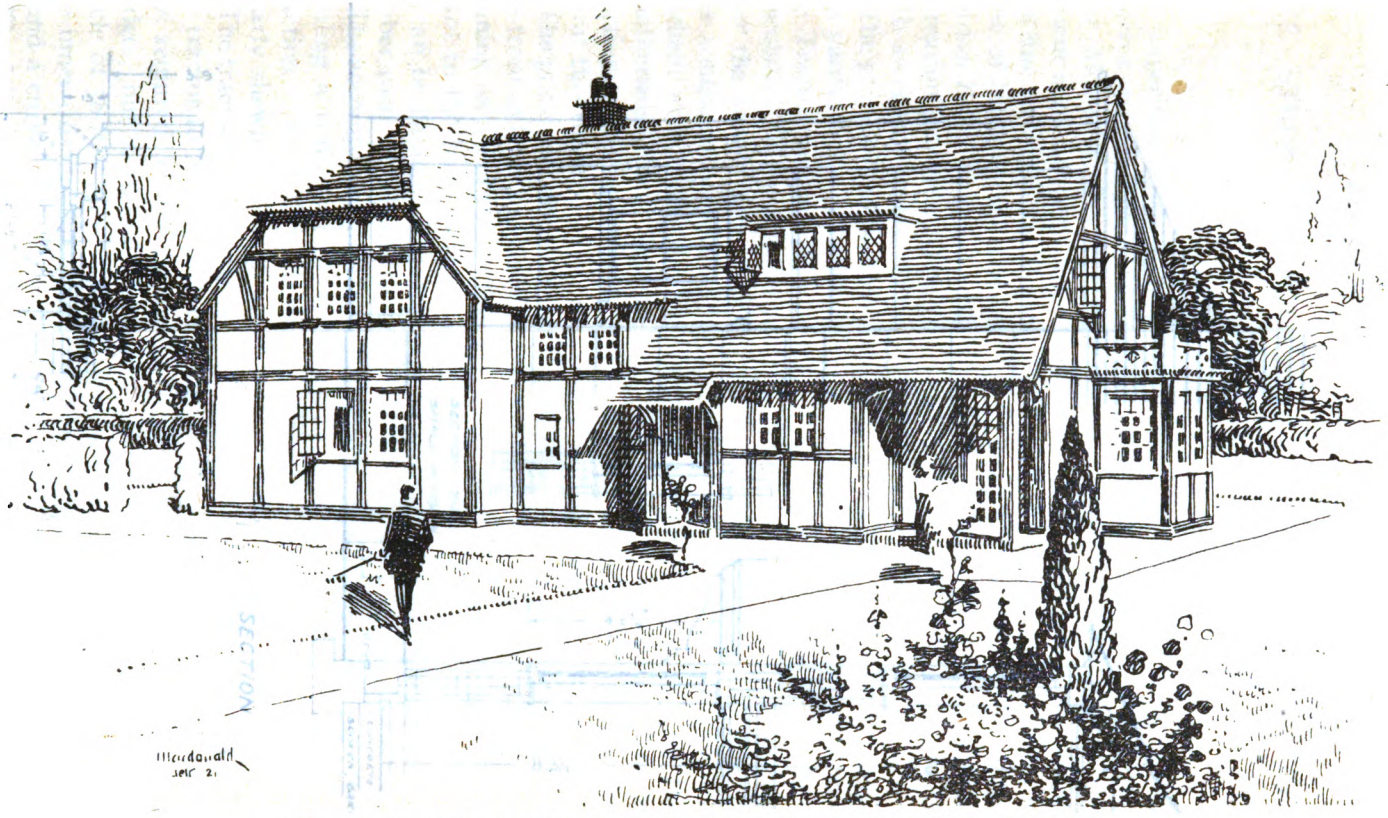

House designed for Erection at Croxley Green, Herts., on the "Kent" System.
Accommodation: 3 Reception Rooms; 7 Bed and Dressing Rooms, Servants' Hall, Bath-room, etc.
Estimated Cost, £1,500.

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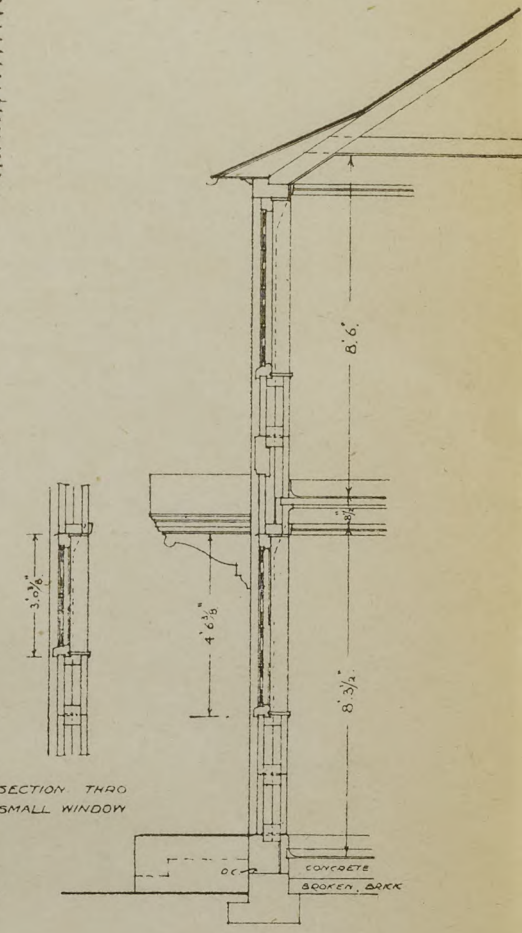
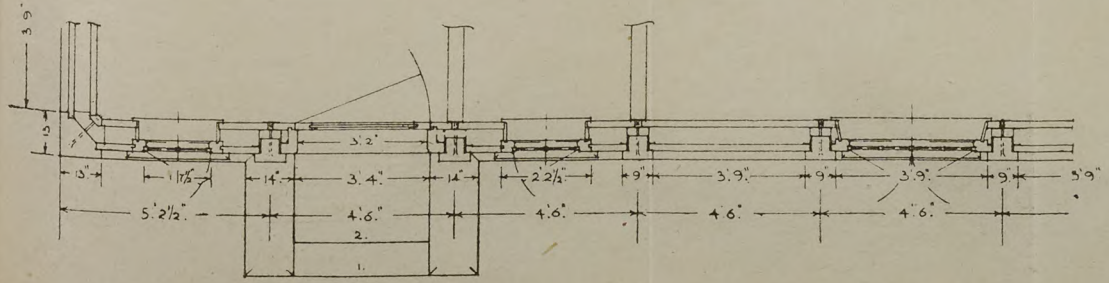
COL. KENTS PATENT CONSTRUCTION FOR HOUSING SCHEMES.

DETAILS.

ELEVATION.



SECTION



PLAN.

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PROFESSIONAL NOTE.

THE STRONACH DUTTON SYSTEM OF ROAD RAIL TRACTION.

(COMMUNICATED BY THE R.E. BOARD.)

AN experimental installation of this system, with an improvised Tractor, working on a five-mile length of line at Chobham Ridges, near Aldershot, was recently inspected, and it is thought that the system is of sufficient interest to merit report in the *R.E. Journal*. The line on which the Tractor is working was laid in 1920, with the view of bringing up 8,000 tons of soil from Lucas Green, near the Gordon Boys' Home, to Blackdown Barracks for the formation of recreation grounds. The gauge of the line is 60 cm., laid partly with steel and partly with wooden sleepers.

The gradient for the first three miles is 1 in 30, followed by about 800 yards of 1 in 20, with a maximum gradient of 1 in 12, on which the Tractor works. The remaining portion of the line is slightly downhill. This particular alignment was chosen, partly to circumvent the danger area of Bisley Rifle Ranges, and partly because it was considered advisable, for constructional reasons, to bunch the gradient and locate the line on the good surface afforded by the Heatherside Road, and to use the Stronach Dutton System of traction which was brought to the notice of the Aldershot Command about this time.

The principle adopted in the Stronach Dutton System is to support the front axle of a short-wheel base tractor by a four-wheeled bogie running on a Decauville line. A draw-bar is carried from the bogie pivot to the back of the tractor for the attachment of such trucks as can be hauled. The tractive effort is produced by the ordinary rubber road wheels of the tractor running on the ballast.

The accompanying plates show the most recent pattern of tractor hauling a train and converting from road to rail or rail to road traction. The ball point on the bogie and the long draw bar are clearly shewn.

The tractor cannot reverse, and a circular track is required to enable the tractor to turn at each end of its run. A circle of 75-ft. radius was required for the improvised Berna Tractor used at Chobham Ridges, but a special tractor has been produced with a turning circle of 38-ft. radius. If the wheel-base of the tractor is too long the inner driving-wheel has a tendency to approach the inner rail round a curve.

The following is an extract from the inspection report :—

" The party witnessed the tractor taking a load of about 16 tons over the track. After hauling the load up the hill, the tractor,

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without the load, went round the circle—a radius of about 75 ft.—without difficulty, after which a demonstration was made of unshipping the bogie enabling the tractor to be used as an ordinary road tractor. The unshipping and reshipping of the bogie was a matter of only a couple of minutes.

" The conclusions drawn were as follows :—

" 1. The tractor is only suitable for use where the track is laid on a reasonably good road surface, or when the permanent way of the tramway is built substantially up to a width somewhat in excess of the ' track ' of the road wheels.

" 2. The ' track ' of the road wheels of the tractor must be greater than the length of the sleepers. With the Berna Tractor employed this necessitated the use of very short steel sleepers with the 14 lbs. Decauville rails."

The later design of tractor has a considerably wider track.

" 3. It was considered that any road on active service would seldom be of sufficient width to enable a portion of it to be devoted to a tramway, and that it must be assumed that tramways would always be off the road.

" 4. For tramways built off the road, normally the construction of a tramway and track for a road rail tractor will involve a greater width of formation and more ballast, and the maintenance, due to the wear of the track under the road wheels, will be heavier than in the case of a rail tractor. Under the heavy traffic conditions on active service, generally speaking, these disadvantages will outweigh the advantages of increased tractive effort, steeper grades and sharper curves (and possibly lighter section rails) utilizable with the road-rail tractor. Exceptions might be cases where ballast is plentiful, and for short lengths of line in difficult country.

" 5. Accordingly, apart from exceptional conditions such as are suggested below, the system would not prove economical.

" 6. For certain specific engineering schemes, the use of such system may be useful in military operations.

For instance—

(*a*) In certain cases, a more economical location for a tramway or light railway might be obtained by the inclusion of a short section with very steep gradients, the road-rail system of traction being used over this section.

(*b*) The system would be well adapted to a rocky or desert country where, under normal conditions, road transport can be used without extensive preparation of metalled roads, and where the country is sufficiently difficult to prohibit the economical or rapid construction of a light railway with grades suitable for ordinary adhesive rail tractor."

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It has been suggested that difficulties in connection with the construction and maintenance of the road-wheel tracks might be reduced by the substitution of a "track vehicle" in place of a wheeled one.

The most recent pattern of tractor, a twin 25 h.p.-engined Sou-Tractor, as exhibited by the Road Rail Co., was seen at Neasdon, working on a track composed of a few inches of cinders on the top of a heavy clay soil. It hauled four empty wagons, total weight about seven tons, easily on a slight incline and round a curve of a radius of 38 ft. The weight of the tractor is about five and a half tons and weight on driving wheels three and three-quarter tons. The draw-bar in this case is attached to the underside of the bogie. The clearance between the draw-bar and the differential is only about three inches, and it appeared that if by mischance the driving wheels sank far into the ground there might be some damage. This risk is somewhat modified by the unusual size of the wheels.

The extra gearing, due to the use of twin engines must entail some loss of power. But, as each engine can be used independently, delays, etc., due to engine trouble, can be avoided under certain conditions.

It appeared to the observer that the springs under the engine were too easy, as the body rocked excessively on the track.

The tractor in question is on order for the Uganda Government.

It is stated that it has travelled four times between Wolverhampton and London with entire satisfaction.

The following tables give further particulars as regards gear ratios, speeds and loads :—

Gear Ratios.

Reduction Gear 1·5 to 1 Rear Axle 8·24 to 1

Gear Box 1 to 1 Top

1·73 to 1 3rd.

2·9 to 1 2nd.

3·1 to 1 1st.

5·5 to 1 Reverse.

Overall Ratios.

12·36 to 1 Top.

21·4 to 1 3rd.

34·8 to 1 2nd.

62 to 1 1st.

68 to 1 Reverse.

Tractor speed at Engine speed of 1,000 R.P.M.

14·15 to Top.

8·18 3rd.

4·92 2nd.

2·82 1st.

2·57 Reverse.

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Max. Loads. Grade.	Per Cent.	Gross Load in Tons.	Grade.	Per Cent.	Gross Load in Tons.
Level		250	1 in 14	7·15	26
1 in 100	1	125	13	7·7	24
75	1·34	100	12	8·35	22
50	2	82	11	9·1	20
40	2·5	66	10	10	18
30	3·34	52	9	11·1	15
25	4	45	8	12·5	13
20	5	39	7	14·3	11
18	5·55	34	6	16·7	8½
16	6·25	30	5	20	6
15	6·7	28	4	25	3¾

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THE STRONACH DUTTON SYSTEM OF ROAD RAIL TRACTION.

Road Rail Tractor, 50 h.p. Standard Convertible Type, with Train.

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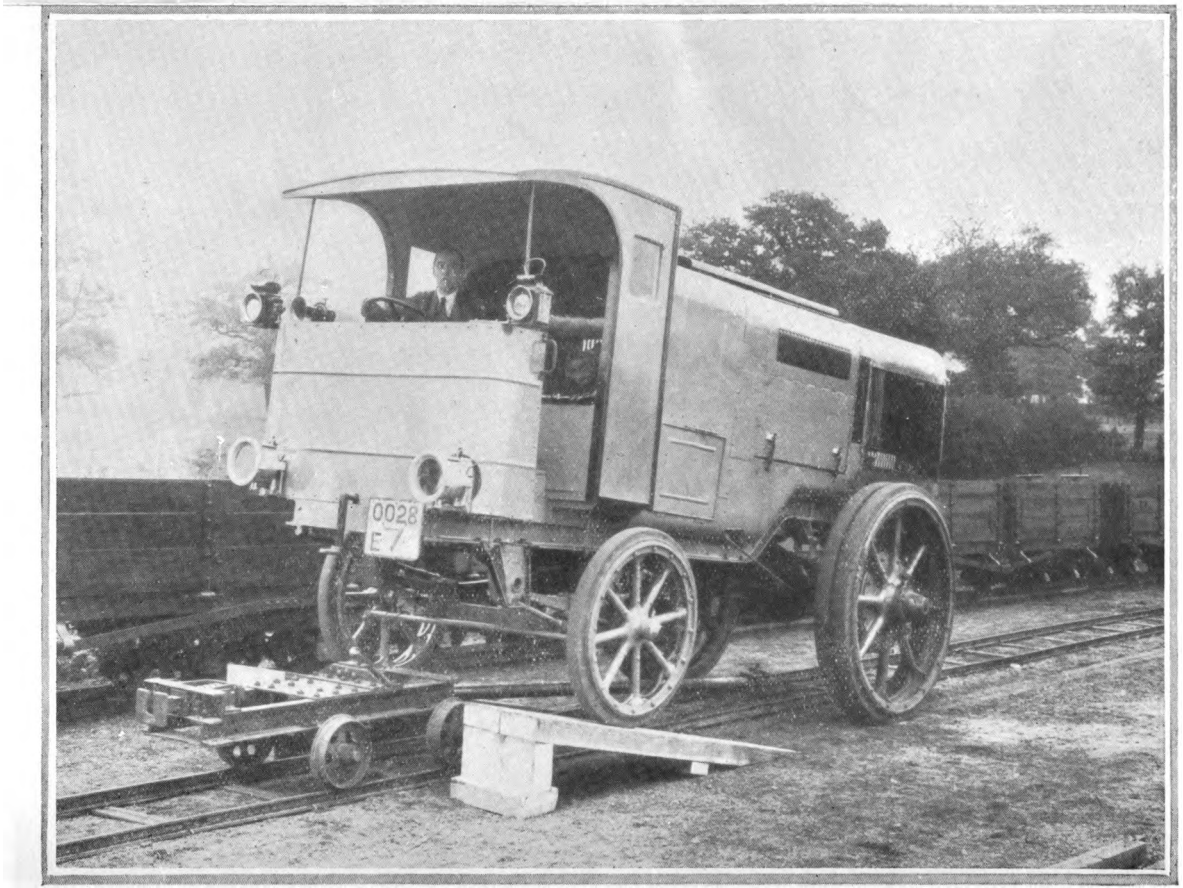
THE STRONACH DUTTON SYSTEM OF ROAD RAIL TRACTION.



Converting from Road to Rail or Rail to Road by Temporary Sleeper Ramps.

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Lieut.-Colonel P. G. von Donop, R.E.

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MEMOIR.

LIEUT.-COLONEL P. G. VON DONOP, LATE R.E.

I HAVE been asked to compile a Memoir of the late Lieut.-Colonel P. G. von Donop, and I am only too glad to do anything which may help to perpetuate the memory of one who represented a very fine type of Royal Engineer Officer, was a highly valuable servant of the State, and a most delightful companion.

I have been assisted in this memoir by some of his brother officers who were closely associated with him in the many activities of his career.

Pelham von Donop was the son of Vice-Admiral E. P. von Donop and was born at Southsea on the 28th April, 1851.

Like many of the best type of British officers he came from a "Service family," now represented by his younger brother, Major-General Sir Stanley von Donop, to whom he was greatly attached, and who, as Master-General of the Ordnance, was closely associated with the work of the Royal Engineers.

He was educated at Somerset College, Bath, previous to passing into the Royal Military Academy in 1869, and obtained a Commission in the Royal Engineers in December, 1871.

He was from the first both a good worker and a good player, representing his school both at cricket and football, and playing in the Royal Military Academy Cricket Eleven in the years 1870 and 1871.

Von Donop joined the School of Military Engineering at rather a remarkable time. It may be said to have been the advent of a new era in the history of the Royal Engineers.

Previous to this time, the history of the Corps is a distinguished and a highly honourable one, but its duties had been chiefly confined to the construction of fortifications, military buildings, and survey work, individual officers and men being, however, not infrequently employed in extraneous duties both civil and military.

New discoveries and inventions and their application to military matters now began to take effect. Improvements in weapons and methods of defence were introduced, together with better means of communication; such were the development of railways and telegraphs for military purposes. About this period, also, it was decided that the Royal Engineers were to be entrusted with the submarine defences of our ports. It will be seen later that von Donop was

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destined to take an important part in all three of these new activities of the Corps.

To meet these additional responsibilities, the number of young officers at the School of Military Engineering was largely increased and a fresh impetus was, I think, given to all branches of study, duty and, last but by no means least, to games and recreation.

It can readily be imagined that von Donop soon adapted himself to these conditions. Energetic, accurate, quick and conscientious, ready to rise early or work late, he found time without neglecting his professional duties to become pre-eminent in games, for which he had a great natural capacity, and it is this side of his career which will be dwelt upon in the first place. Whilst a good cricketer he was an exceptionally fine Association football player; in fact, the *Sporting Press* at that time described him as "The Prince of Dribblers," and the description was not inapt though he would have been the last person to admit it. In addition to assisting to maintain the R.E. football team in the very front rank of clubs, he twice played for England against Scotland, in 1873 and again in 1875; he was also one of the fortunate R.E. team who won the Association Challenge Cup in the year 1875. His powers as a cricketer were perhaps only fully developed after he left the S.M.E., when his name became somewhat of a terror to most of the Garrison and Naval Elevens at Portsmouth and Bermuda, where he was afterwards stationed.

At Chatham, however, in 1875, he made a century in the celebrated match, R.E. *v.* I.Z., when the R.E. made 726 for 8 wickets and the I.Z. never got an innings.

On leaving the S.M.E., von Donop was posted to the 28th Submarine Mining Co., under the command of another well-known cricketer, Capt. Heneage. After two years this Company was moved to Gosport and became famous for defeating all comers (Brigade of Marines, R.M. Artillery, etc.) at cricket. It was also the best shooting Company in the R.E.

After one-and-a-half years at Gosport the 28th Co. was sent to Bermuda, where they again carried all before them at cricket, finally playing a combined Naval and Military Eleven representing the World. Von Donop and his brother officer, C. K. Wood (of the 28th Co.), also won the Open Championship Doubles Lawn Tennis whilst at Bermuda.

It may be interpolated here that later von Donop became a first-class lawn tennis player, finally winning the West of England Championship at Bath in 1884.

On returning to England in October, 1880, von Donop was soon afterwards appointed to the Postal Telegraph Service at Bristol, which was then the Headquarters of the R.E., entrusted with the charge of the Postal Telegraphs to the South of the Thames.

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Work in a Postal Telegraph Unit was of an entirely different character to that of the R.E. units to which he had previously been attached. The personnel was scattered in small parties, in many cases even singly, over a large area, and frequently carried out their duties under and alongside civilians. At this time also the military branch of the Postal Telegraphs was still in its infancy and more or less on trial; hence many difficulties and prejudices had to be overcome by the pioneers of this service. Doubtless it was during this period of his career that von Donop developed those special qualifications which proved to be so valuable when he was placed in supreme charge of this branch of the service, and later when he became an Inspector of Railways. That he carried out his duties satisfactorily in every respect whilst at Bristol is indicated by the fact that, in 1884, he was specially selected to join the 8th Railway Co., R.E., under the command of Major (now Major-General) D. A. Scott, this company being under orders to proceed to Egypt on active service.

Major-General D. A. Scott has sent me a very interesting account of the work done by this company in Egypt, more especially as far as von Donop was concerned. Incidentally it illustrates the difficulties experienced and overcome in the first British campaign where military railway companies formed a very important feature in the supply of an army in the field.

"On the 13th June, 1884, orders were received at Chatham to make up the 8th Co., R.E., to war strength and three extra officers were at once posted to the Company. Von Donop was one of these and he was placed in command of the second half-Company, or the traffic portion. Between this date and the date of embarkation of the Company for Alexandria, through the courtesy of the Chairman and Directors of the L. C. and D. Railway, the N.C.O.'s and men of the Company were drafted on to this railway for instruction and training, and von Donop exercised a general supervision of his men during the time they were thus employed.

"The embarkation of the Company took place on the 3rd September, 1884, and it arrived at Alexandria on the 15th September, when it was at once pushed up the Nile to Wady Halfa, the terminus of the Soudan Railway, which place was reached on the 4th October.

"The working of the railway was in the hands of a scratch Staff, and with its broken-down engines and dilapidated rolling stock was found to be in a state of the utmost confusion, being practically at a standstill.

"At the beginning of November I was sent for by Sir Redvers Buller and informed that I was to have unfettered control of the Railway and that as Director of Railways I was to have free access to the C. in C., and I was also to have a free hand in making arrangements for the efficient working of the Line.

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"Von Donop was appointed Traffic Manager, and he retained this appointment for the time the railway remained under military control, *i.e.*, until the 19th April, 1886, and he then returned to England with the Company in June, 1886.

"I may state here that this was the first experience von Donop had in the practical working of railways. I think I can best give an idea of how he carried out his important duties by quoting my appreciation of his services in my report of the working of the London military railway.

"'Capt. P. G. von Donop, R.E., succeeded Mr. —— as Traffic Manager; although this officer had little previous experience of railway management he at once picked up the work and has performed the onerous and important duties of Traffic Manager in a most satisfactory manner. His task has been a very difficult one, but it has been carried out in a manner that does him the greatest credit.'"

He was further reported upon by the G.O.C. Commanding, in his 'Report on Railways, Nile Expedition,' as follows:—'The onerous duties of Traffic Management were ably conducted by Capt. von Donop.' "I also reported that von Donop had done his work, often under great pressure and difficulties, in a manner deserving of commendation and reward. I should like to add a personal tribute to the way he carried out his duties. During the whole time he was under me we were on intimate terms. He was closely associated with me in all the details of his work and I always knew how things were going. Although he had had practically no experience of traffic management, at the best of times a troublesome business, he seemed to fall into the right groove instinctively. In addition to his ability he was full of good sound common sense and totally devoid of cranks and fads—he was likewise possessed of a keen sense of humour which served to leaven the mass of disappointments and troubles. He was a most loyal worker and friend, and, while he had plenty of strength of will, he was invariably courteous and tactful, which served to make rough places plain. In short, he had all the essential qualities of a good Traffic Manager and above all things he was a 'gentleman' *au bout des ongles*. One need scarcely say more than this. Personally, I shall always look back at the time we spent to gether in the 'womb of the desert' with pleasure and to his memory with affection."

On his return to England, from Egypt, in 1886, von Donop was sent again to the S.M.E., where he remained for two years, and then, after a short spell at Harwich, he was selected for the appointment of Inspector of Submarine Defences in India, succeeding Major Carter, R.E., who had died rather suddenly. This appointment was specially important at the time as the plans of the re-organized Submarine Mining Defences were under consideration. Brig.-Gen.

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Tudor, who served under von Donop in India, says that " the plans were approved soon after my arrival, 1889, and we set to work to survey the harbours and prepare the stores. The whole of this work was completed while von Donop was I.S.D. in India. We also had some actual rehearsals of laying out the mine-fields when von Donop was present. Before he left India the whole of the S.M. Defences, including electric lights, of the Indian Ports were complete and efficient, no mean accomplishment in those days of parsimonious governments. Von Donop had an extraordinary knack of seizing on the essentials of a matter and clearly stating them in his reports. I think he accomplished with less correspondence more than any Commanding Officer I served under in pre-war days. He cut returns down to a minimum; he was an ideal C.O., always sympathetic and helpful in our difficulties." Col. H. E. Tyler, who succeeded him, says that ".he left no disputes of any kind and no arrears of work whatsoever to me, and gave me all the help he could."

Whilst in India, von Donop had the good fortune to meet his future wife, Miss Ethel Farren, daughter of J. Orr, Esq., of the High Court of Bombay, who, after his marriage in 1890, was his constant companion, and nursed him most devotedly during his last long illness.

On his return home von Donop received another important appointment, being made Officer Commanding the 2nd Division Telegraph Battalion, and was entrusted with the supervision of the whole of the Postal Telegraphs south of the Thames, with Headquarters in London. The responsibilities of this appointment were extensive, as, amongst other things, they involved the whole engineering requirements of the Postal Telegraphs in this area, including heavy new construction work, costing large sums of money. Von Donop's previous experience at Bristol was no doubt invaluable, more especially in dealing with the many questions in which the public were concerned, and in the harmonious interworking of the military and civil sides.

Brig.-General Boys, who was associated with him at this time, says:

" In such circumstances as these, von Donop's personal characteristics stood the work in good stead. Firm, yet considerate to his subordinates, courteous and genial to all with whom he came in contact, he helped greatly to overcome the prejudices of the civilian element and left behind him an atmosphere which tended to smooth the course of those who followed him in the difficult and delicate positions they held."

After the completion of his four years' tenure of office with the Postal Telegraphs, von Donop was, in May 1898, appointed Commanding Royal Engineer at Dover, where he remained for rather over a year when he was made an Inspector of Railways under the

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Board of Trade. He now commenced, what perhaps may be called the most valuable part of his official career extending over a period of 17 years, during the last three of which he was the Chief Inspector. Here again, as in the case of the supervision of Postal Telegraphs, it is a very difficult task which Royal Engineer Officers have to perform, and one requiring tact, courtesy and impartiality, as well as an intimate knowledge of technical matters.

How well von Donop carried out those onerous duties, and in what degree he possessed the necessary qualifications for his post, is clearly shown by the following remarks of Colonel Sir H. A. Yorke, late Chief Inspector.

"Von Donop joined the Board of Trade while Marindin was Chief Inspecting Officer of Railways, and no one could wish to serve under a better Chief. Von Donop threw himself with characteristic energy and zeal into his new duties and soon mastered the principles of block working, signalling, and all the other technical details of the construction and operation of an English railway.

"He was 'thorough' in all that he undertook, and he never spared himself in the execution of his duty. His reports were well reasoned and his decisions were always accepted as conclusive and just. The geniality of his disposition made him a general favourite wherever he went, and he was affectionately regarded, not only by his colleagues at the Board of Trade, but also by all the railway officers with whom his duties brought him in contact. His fondness for golf was well-known, and often after a hard day's work he would finish up on the local golf course, wherever he might be, in a round with one or other of his railway friends.

"In 1913, he succeeded to the post of Inspecting Officer of Railways, and in 1916 he retired from the public service under the inexorable law known as the age limit. His death is deeply deplored by those railway officers with whom he had been associated in his official capacity."

The following extract from the *Railway Gazette* of August 25th, 1916, when he retired from the appointment of Chief Inspector is much to the same purpose:

"Colonel von Donop was an ideal civil servant, painstaking, approachable, and always willing to hear both sides of a question. His inspections and enquiries were thorough, nothing being taken for granted, but always with that reasonableness that made Railway Officers most willing to assist him."

. . . . . .

This was the close of von Donop's official career, a career most useful and varied, carrying much responsibility, and exhibiting a rare combination of marked ability and special personal qualifications.

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After his retirement, he resided at Camberley with occasional visits to the South of France, his chief interests being gardening, golf and the society of his many friends. Early in 1921 he developed a serious illness which eventually proved fatal on the 7th November. During this long, painful period, he exhibited the remarkable patience and fortitude so typical of his character.

He was buried at East Sheen on the 10th November and round his grave were assembled many of his old comrades of the Royal Engineers. Amongst them were:

Major-Generals: D. A. Scott, Duperier, Sir Spring Rice.

Brig.-Generals: Bowles, Lake.

Colonels and Lieut.-Colonels: Abbott, Addison, Blackburn, Boys, Olivier, Pringle, B. B. Russell, Wilkieson, Sir Arthur Yorke.

Amongst the very many letters of sympathy which were received by his widow, were not a few written by young men who had received benefit from his advice or personal efforts. One of these wrote:

"He was so nearly an ideal man that the inspiration of his example must have helped many people. I know that I owe a tremendous lot to him. Always when I have wanted sound advice, he invariably went out of his way to help me. I know the advice he gave me was not just a hasty opinion, but collected from every quarter where it could be usefully found . . . . My hope is to live even half as good and useful a life."

This extract seems to me to strike the keynote of his character and disposition; it is impossible to describe the charm of his personality. Colonel C. K. Wood says "he was a staunch and loyal friend, the best one can have."

Like his intimate friends Marindin, Merriman, and Renny-Tailyour who have "gone before," von Donop undoubtedly represented a type of R.E. Officer of whom the Corps may justly be proud.

R. M. RUCK.

THE LATE COLONEL H. W. RENNY-TAILYOUR.

THE Officer who wrote the Memoir on the late Colonel H. W. Renny-Tailyour which appeared in the *R.E. Journal* of September, 1920, has asked that an omission which was made in that Memoir may be made good. Colonel Renny-Tailyour not only played in the final Association Cup Match of 1875, but he kicked both goals scored in that Match by the victorious R.E. Team.

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REVIEWS.

THE RIDDLE OF THE RHINE.—CHEMICAL STRATEGY IN PEACE AND WAR.

By VICTOR LEFEBURE. (Collins, Sons and Co. Price 10s. 6d.).

This is a very important and very interesting book and one which should be read, and indeed studied, by every soldier. The importance of the subject may be gauged by the fact that Field-Marshal Sir Henry Wilson has been at the pains to write an introduction in which he emphasizes the necessity for a full knowledge of the facts regarding gas warfare on the part of the public. If it is necessary to the public, how much more so to the soldier?

It is no doubt owing to the secrecy which necessarily shrouded to a large extent the use of gas by the Allied forces during the War that so little is known of the broad strategical principles which underlie the employment of this new weapon of war. Major Lefebure sets himself the task of bringing out these principles, of showing how in this matter strategic policy is closely bound up with economic policy, and how a monopoly in chemical industries on the part of a single nation may constitute a formidable military danger to other nations. The problem of how to deal with this situation as it exists after the war is what he calls "The Riddle of the Rhine."

The author gives a detailed narrative of the chemical warfare operations on the Western Front. Beginning with the first surprise use of chlorine from cylinders by the Germans at Ypres in April, 1915, and the retaliation by the English and French at Loos in September of the same year, he traces the struggles for the initiative by each side to the end of the war. He shows how each adversary made a constant endeavour to penetrate or circumvent the protective mask of his opponent, sometimes by the introduction of new substances and sometimes by improved methods of tactical employment. Of the latter the most striking example was probably the use of the Livens projector by ourselves in 1917, and of the former the introduction in the same year of mustard gas by the Germans. The development of the use of gas in artillery shell is similarly traced both in its technical and its tactical aspects.

Major Lefebure's account of the successive stages of these operations is clear, interesting and accurate. Without sensationalism or exaggerations he gives a sane and well-balanced picture of the great importance that chemical warfare has attained in modern war. He shows how the

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necessity for using respirators imposes on troops a very considerable physical strain which reduces their mobility and capacity for using their weapons, and also entails a special and strenuous form of training and a particularly high standard of discipline. The magnitude of the share taken by gas warfare in modern operations is illustrated by the fact that of the casualties suffered by the American armies in France those due to gas amounted to 75,000 in number, or more than a quarter of the total; also by the fact that in 1918 the German divisional ammunition dumps contained normally 50 per cent. of gas shell, and that in the preparation for certain attacks their artillery programmes included as much as 80 per cent. of gas shell for certain objectives.

The author goes on to review the production of chemical warfare materials by Germany and the Allies during the war, and in particular the immense military potentialities of the great German dye and chemical industries on the Rhine. He shows that the theory advanced by some public men that the employment of gas in war, or the manufacture of war chemicals in peace, can be prohibited by convention or treaty is in actual fact a vain dream. He points out that chemical plants and factories which had taken forty years to build up could be converted to the production of war chemicals in forty days. He states that gas is the outstanding case of a weapon whose manufacture it is difficult to prevent, and that no convention, guarantee or disarmament safeguard will prevent an unscrupulous enemy from employing poison gas, especially if that enemy has discovered some new powerful agent, or possesses, as Germany does in her well organized and strong chemical industry, a ready means of producing such chemicals in bulk at practically a moment's notice.

It is evident, therefore, that chemical warfare has become an inseparable component of modern war, and that there is no hope of abolishing it except by abolishing war itself. The "riddle" therefore is to discover the means of preventing Germany's dominant position in the chemical world from being a menace to the world's peace. Major Lefebure propounds his own solution to this riddle. It is probable, however, that there are many men who will not consider his solution a practicable one. Nevertheless, he is well justified in his endeavour to make the public realize the serious and difficult nature of the issues involved.

By soldiers, above all, it is essential that these issues shall be understood. There is a too prevalent disposition, even in the ranks where long experience might have been expected to bring mature judgment, to discuss the matter by the light of an antiquated sentiment or to shelve its consideration by an ostrich-like disposition to shun plain facts. To all grades a study of Major Lefebure's pages, whether all his arguments are admitted or not, cannot fail to be of advantage and to tend to the production of a clearer vision in regard to this important question.

H. F. THUILLIER,
Major-General.

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WORK OF R.E. IN EUROPEAN WAR, 1914–1919. SIGNAL SERVICE (FRANCE).

Major Priestley has produced under this title a valuable contribution to the literature dealing with the special work of the Royal Engineers during the War in France. It is to be hoped that a further instalment, as suggested, for the other theatres of war will be forthcoming.

In the present volume, written with enthusiasm for his subject and with great care, the author has managed to give a very full and connected account of the history and development of the Signal Service during the four years of hostilities.

It is perhaps unfortunate that so large a part of the book deals of necessity with the development of buried cables; these, though they undoubtedly played a prominent part in the War, were at the last fast losing favour with Signal Officers working in the forward zones. When position warfare was brought to a close, Signal Officers were turning in bewilderment towards any alternative means that would give them the same measure of security as "6-ft. buries" had provided in the great battles of '17 and '18.

While mentioning buried cables, it may perhaps be noticed that the author, on page 214, has not done justice to the prominent part played by them in the Messines battle, or in the *latter half* of the fight for the Paschendaele Ridges. In the former battle, Whytschaete was successfully connected up with buried cable a few hours after the attack opened, through the efforts of a battalion as a digging party; while throughout both battles cables were successfully maintained by all the Corps engaged. The author fully realizes the waning confidence of Signal Officers in wire carried communications, and throughout the book lays stress on the efforts made to replace them with alternative means.

Major Priestley, when dealing with the development of earth induction, perhaps hardly does justice to our Allies, for it is safe to say that no real success attended this method previous to some very successful demonstrations given at Zuytpene by a lieutenant of French Artillery at the invitation of the 2nd Army Signal School. No Signal Officer who was privileged to be present at these demonstrations will wish to give the credit elsewhere.

The author properly points to the uphill fight that wireless had to maintain throughout the War to gain even that measure of success it obtained in the later phases of the struggle. The prejudice of Staff and Signal Officers is mentioned as the stumbling-block, but the author might also have given a further reason. Nine-tenths of the Signal Officers, until trained during hostilities, were ignorant of even the rudiments of wireless, for, before the war, wireless was regarded as a mystery, to be jealously guarded by a few. In the earlier months of the War this policy was maintained with all due solemnity, even the Senior Signal Officers, outside the magic circle, were considered unworthy to approach its shrine which was safely ensconced within the hallowed precincts of G.H.Q. Surprise can hardly therefore be felt that a great dread of this magic god grew up among the great body of Signal Officers, and it is safe to say that it was this dread among the Junior Officers at the front, as much as the prejudices of Staff and Signal Officers, that was

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responsible for the slow progress made by this useful auxiliary in gaining its rightful place in the signal system. It is interesting to note that the Colonial Corps, as might be expected, led the way to the advancement of wireless into the front line.

To the careful student of this work (and it should be studied by all Signal and Staff Officers), many lessons can be learned; these are well enumerated on page 41, but perhaps one more lesson should be added. The Signal Officer of the future will require to be a man of high scientific attainments, for everything points to the higher branches of science being called in more and more to his aid. The era of black and white poles has passed, that of cable is passing—wireless, in forms perhaps at present unknown, may become the mainstay of the future Signal Officer: he will be useless unless he can utilize it.

Major Priestley is to be congratulated on the production of so useful a work with such a paucity of material, as he complains, within his reach.

A.R.H.

DIRECTIVE WIRELESS TELEGRAPHY.

By L. H. WALTER. (Pitman's Technical Primers Series, 2/6.)

Electro-magnetic waves have many properties in common with light, but so far it has not been found possible to construct a wireless projector analogous to a searchlight. If such were possible, the amount of energy required to communicate with the most remote parts of the earth would be reduced to trifling dimensions and the interference of one station with another could, by suitable arrangements, be reduced to a minimum. In the present state of the art of Directive Wireless, the most that can be done is to increase the energy in one direction at the expense of the other directions. A plain aerial radiates energy somewhat in the manner of a point source of light: a directive aerial is a badly focussed projector which "spills" the greater portion of the light. Developments in this line are rapid and doubtless means will be ultimately found of directing the waves into a parallel beam or ray. The principal application of directive wireless is in determining the position of a vessel or aeroplane.

Reception can also be made directional, *i.e.*, the aerial can be made to receive mainly from any desired direction at will. By rotating the aerial or by analogous methods, the compass bearing of any distant sending station can be determined with fair accuracy, say to within 2°. If a sharp focus were possible, this figure could be improved upon greatly. If the bearing of a distant sending station, such as a ship, is observed simultaneously from two or more stations the position on the chart can easily be found. A number of radiophares or wireless "light-houses" have been established throughout the world, particularly at the entrances to large ports. A ship approaching and wishing to fix its position calls up the radiophares which take the ship's bearing. The bearing from each radiophare is then telegraphed over land lines to a

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control station which, by means of a chart, similar to a gunner's P.F. chart, determines the ship's position and transmits it to the ship. Alternatively, the ship may be fitted with a directive aerial and by determining the positions of two or more known sending stations can find its position.

The book under review deals fully, but concisely, with these applications and other similar methods, the various systems being briefly described and the theory explained. As the book deals exclusively with the directive aspect of wireless telegraphy, a knowledge of the general theory and the ordinary types of apparatus is assumed. The book is attractively got up and contains numerous diagrams and illustrations and can be recommended as giving a sound exposition of the present position with regard to the use of wireless for navigation both at sea and in the air.

The use of directive aerials in order to increase the range or decrease the power for a given range and also as an aid to selectivity is also fully dealt with. An interesting application is the elimination of strays.

The extended use of wireless was only made possible by the introduction of the triode valve amplifier which permits quite small receiving aerials to be used.

The book is clearly printed on good paper and the diagrams are clear and well arranged. A very complete table of contents and list of illustrations is provided. The index, however, might with advantage be fuller. There is an excellent list of references.

R. CHALMERS BLACK,
Captain, R.E.

HANDBOOK FOR THE LIMBLESS.

Edited by G. HOWSON and Published by The Disabled Society, 48, Grosvenor Square, London, W.1. Price 1/-; Post free 1/5.

This little book, which has been published at the request of and with the assistance of men who lost limbs in the Great War, deserves to be widely read by those who wish to play the Good Samaritan towards their limbless neighbours.

F.E.G.S.

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NOTICES OF MAGAZINES.

MILITÄR WOCHENBLATT.

No. 22.—*General Le Rond and General Nollet.* Lieut.-General von Cramon makes a violent attack on these two officers, who are in charge of affairs in Silesia, and of the Inter-Allied mission of control respectively. They embody, he says, French vindictiveness towards Germany and their activities reveal the preponderating position which France has gained in Europe. He then contrasts, to the detriment of the French, the attitude taken up by the British and Italians and, quoting Wellington when he prayed for " night or the Prussians " at Waterloo, says that Lloyd George will also soon pray for some counterpoise to the French weight. Napoleon, he says, would be astonished if he could see how proud Albion now bows down to France. Having thus done his best to make bad feeling between the Allies, he proceeds to belittle the French representatives and complains of their being in close touch with each other by means of " secret communications," though it is difficult to see why they should not ; also of their sometimes exchanging individuals of their staffs. The fact that General Nollet takes strong measures whenever any of his subordinates are not properly treated while carrying out their duties of inspection is another thing that rankles. As usual, he concludes with a threat as to what France may expect when Germany is herself again.

A French View of the Strategy of the War.—General von Kuhl, reviewing De Civrieux's book—" La Grande Guerre, 1914–1918," says that it is the first from the allied side to give anything like a fair criticism of events. He objects, however, to its being said that the Germans looted the French wine cellars in 1914, or that the villages were strewn with empty bottles. (As von Kuhl was chief of staff of von Kluck's army, he must have a conveniently short memory). Nevertheless, the book is heartily welcomed, largely because it is hoped that it will help to dispel the opinion, still held by some ill-informed people in Germany, that their armies suffered heavy defeats in the autumn of 1918.

German Graves in Foreign Lands.—Arrangements have now been completed by which the bodies of her soldiers, which lie in foreign graves, can now be brought back to Germany. The difficulties and the expenses, which have to be borne entirely by the relatives, are so great that it is strongly recommended that the graves may be left undisturbed.

No. 23.—*The Washington Conference.* The *M.W.B.* has no use whatever for any talk about disarmament, so long as her neighbours maintain

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armies compared to which her own is negligible. The Conference is not expected to have any substantial results, though some individuals may achieve personal successes.

Memorials in Belgium.—The writer deplores the erection in Belgium and France of so many memorials to the victims of the war among the civil population. He produces statements in refutation of some half-dozen reported instances of atrocities, and would have the conclusion drawn that all reported atrocities are as mythical as he alleges these few are. It appears that the burden of guilt is really beginning to gall the backs of some Germans, and their uneasiness is leading to a demand for action by their government towards discrediting all reports of German atrocities.

King Karl's Dash to Hungary.—A Hungarian correspondent states that the government had no other course open to them but to deploy all their forces against Karl. Not only was his return not at all universally acceptable to the people, but the mobilization of Czecho-Slovakia and Jugo-Slavia showed what might be expected if Karl were accepted. In general, the good progress, which the country has been making, has not been seriously interrupted, and the spirit of the army has not suffered through recent events.

The German Intelligence Service during the War.—General Macdonogh's lecture on this subject has drawn a reply from General von Kuhl. The portions of the lecture to which he takes exception are—

1. That Germany's bad intelligence service had much to do with her defeat;
2. That the rate of Russia's mobilization was underestimated;
3. That the Germans knew very little of the dates and places of disembarkation of the B.E.F. or of its destination.

He says that the loss of the war was due to quite other causes than failure of the intelligence service, for which he claims success as a general rule. As regards Russian mobilization, he says that it was well known that this had recently been considerably speeded up, and that the German estimate of the time it would take was, if anything, underestimated. Of the B.E.F. he says that he, as Chief of Staff of the 1st (von Kluck's) Army, knew on the 20th August that the landing of the British had been completed on the 18th, but thought they had advanced in a rather more northerly direction than was actually the case. On the 21st he knew that the British were further south than he had thought, and were in touch with the 5th French Army, and expected to meet them on the 22nd. "The English had themselves informed us on the matter, through an article . . . which fell into our hands." He admits that G.H.Q. was not equally well informed, and did not, on the 20th, agree with the 1st Army that the landing of the British had already taken place in any large numbers. On the 22nd, however, the 1st Army's information was confirmed by G.H.Q., and on the 23rd, as was, he says, expected, the British Army was met at Mons.

Sport in the Army.—Great attention has been paid, in the new German Army, to the question of recreational training and sport, but it is in getting the regulations obeyed in the spirit as well as in the letter that

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difficulties arise. In a few instances enthusiastic officers have been able to get very good results, but these appear to be rare, and many officers are definitely destructive. The writer, Captain Suren, tries to win these over. He points out how regrettably large the number of officers who have lost their figures is, and how, too often, the fact that an officer is married, or has reached the age of 32, is given as an excuse for taking no active part in games. In fact, he declares little or no progress has been made since the days when the "pot-bellied German" was the laughing-stock of Europe. He attributes the rapid formation and progress of the new British Armies during the war to the devotion of the officers and men to games and athletics.

No. 24.—*The First Note to President Wilson.* General Ludendorff writes to the *M.W.B.* to deny statements that have constantly been made, that he was the originator of this Note. He says that it was not till the 29th September that G.H.Q. raised the question of an armistice, whereas the German Foreign Office had already on 28th September drafted its note. In the Spa Conference on the 29th September, the question of an armistice was discussed by G.H.Q. without any instructions or instigations from Berlin. G.H.Q. was not prepared to accept President's Wilson fourteen points as anything more than a basis for discussion, and was decided in its opinion that no important surrender of German territory, particularly in the East, could be considered. It hoped to bring the German people to understand that their existence was at stake, and a peace by understanding out of the question, and that, therefore, they must fight on. Furthermore, Hindenburg, on the 3rd October, expressed the same views to the Chancellor, but his statement has been omitted from German White Books, as was also one which recommended further fighting. Every effort of Ludendorff's to embody this in the Note, was frustrated by the Government, which must, therefore, alone bear the responsibility for it and its consequences.

General von Cramon, who was chief German representative in Austria, substantiates Ludendorff's statement, and then goes on with his usual ragings against the Treaty, with its confession of German guilt, the Leipzig trials and the terrible results of German party strife. The trials of German officers, which have recently been held in France in the absence of the accused, have especially aroused his indignation. The reason which he gives for this is that the accused were not warned of the time and place of the trials and were therefore unable to come and defend themselves. In this connection it is interesting to note that these trials have more effect than might perhaps be generally attributed to them. In this same number of the *M.W.B.* a German Veterinary Officers' Union takes pains to disown an alleged veterinary officer convicted, in his absence, at Lille, saying that it must be a veterinary assistant and not an officer who is referred to.

No. 25.—*Lieut.-Colonel Hentsch's Mission.* This is fully dealt with by Lieut.-Colonel Loebnitz in the first volume of his "Researches among the archives of the War," and it is claimed that as much is now known of this fateful errand as ever will be. There still, however, remains much that is uncertain, for instance, the text of Hentsch's instructions,

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which unhappily were only verbal; exactly what happened at von Bulow's Headquarters, and what the line of thought of the latter was. This much, however, appears clear; that von Bulow ordered the retreat on a wrong appreciation of the situation, and must therefore bear some of the blame. It is not thought that Hentsch overstepped his authority, when he ordered the 1st Army back, but he is blamed for painting the situation as black as he did. Had he not done so, von Kluck might, it is suggested, have refused to obey G.H.Q. (he was quite capable of doing so !) and all would have been different. Hentsch claimed credit for having, on his return journey, checked the retreat of the 4th Army. Whether he is entitled to any credit for this remains unknown, but at the 5th Army things were quite different for the German Crown Prince absolutely refused to withdraw, in spite of Hentsch's arguments, and did not until ordered by G.H.Q.

L. CHENEVIX-TRENCH,
Major, R.E.

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SOME FAMOUS ENGINEER OFFICERS OF THE NINETEENTH CENTURY.

Lecture delivered at the S.M.E. on 24. II. 21, *by* MAJOR-GENERAL SIR GEORGE SCOTT-MONCRIEFF, K.C.B., K.C.M.G., C.I.E.

IT will, I think, be agreed that, within the limits of one lecture, and especially in this place and with this audience, I have no need to apologise for confining our attention to engineer officers of our own nation only. I omit, therefore, at once, all reference to those of other nations, however famous. Even in our own country, however, the list of famous men is so great that some system of selection is necessary. I would therefore say that the principle which I have endeavoured to follow is the selection of those great men whose influence on the Corps, as it now exists, has been most marked, and whom I have, in some degree, known personally. In endeavouring to place before you some account of their personalities, my desire is not so much to tell of their works, as of their worth, not what they did so much as what they were.

Admittedly such a selection is open to criticism. There are names of famous soldiers, engineers, administrators, etc., of whom I can say nothing, and who, conceivably, in the opinion of my contemporaries, ought to have been put before you rather than those of whom I shall speak. Be it so, I am not concerned to argue the point, nor to claim any right to decide which are the greatest among the many great men of the past. My desire is simply to tell to my younger brother officers how some at least of the great men I knew helped to build up a splendid heritage, so that the account of their worth may help the present generation of officers to maintain the same lofty traditions.

It is generally admitted, however, that among the engineers of the XIXth century there are three names which are pre-eminent, and of whom necessarily some brief mention should be made, the brevity of the allusion being due solely to the fact that I cannot speak of them from personal knowledge, and therefore cannot in any degree supplement what has been written of them in our Corps History. I allude to Field-Marshal Sir John Burgoyne and Lord Napier, and to General Gordon. Burgoyne, who entered the Corps in 1798, became I.G.F. in 1845 when he had passed the age when, by modern rules, he would have had to retire. Yet such was his bodily and mental vigour that he kept going for 23 years more, including the Crimean War in which he took part. Were I to attempt to tell

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the story of his early campaigning in Egypt, Sicily, Sweden, the whole of the Peninsular War, N. America, and later in Flanders, at the time of Waterloo, it would mean the military history of our country for the first fifteen years of the century, and I can only refer you to the very interesting biography written by his son-in-law, Colonel Wrottesley. What I think, however, is apposite to our special purpose, is that in the long period between Waterloo and the Crimea he was by no means content to rest on the laurels he had already gained, but was ever seeking how to keep abreast of modern engineering and use that science for national defence and national welfare. He was for 13 years employed on civil works in Ireland*, at a time when railway enterprise was rapidly developing, and it was in recognition of his services in this respect that he received the honour of being selected an honorary member of the Institution of Civil Engineers, being one of four R.E. officers to be so distinguished in the century, the others being Sir Lintorn Simmons, Sir Andrew Clarke and Lord Kitchener.

In Lord Napier's case, active service came comparatively late, after he had been for 19 years on civil works—valuable years of experience on canals, roads, barracks, etc., but so much had this occupied his energies that I have been told that when in 1845 he was appointed to command the engineers in the first Sikh War, he expressed diffidence in his own military capacity. Yet he must have been what Stevenson calls "a bonny fighter." He had two horses shot under him at Mudki and Ferozeshah, and in the latter battle—sometimes called "the Waterloo of India," where the issue of the fight was for a while very doubtful, and where both the Governor-General and the Commander-in-Chief were present—Napier charged on foot with the infantry and was severely wounded. I may be pardoned if I allude to an incident of personal interest. My father, who was an infantry subaltern and took part in this assault on the Sikh entrenchments, rendered some trifling aid to Napier, who afterwards was kind enough to acknowledge the service in generous terms. In the second Sikh War Napier was again wounded at the siege of Multan, and later, in the Mutiny, he was wounded for the third time at the siege of Lucknow. But apart from all this personal exposure he was both a skilled military engineer and a daring leader of men. For it was not only in the capture of strongholds and the crossing of rivers that he became famous, but perhaps most of all in the relentless pursuit of the rebel leaders in the Central India campaign,

* In 1835 Colonel Burgoyne (as he then was), with some other eminent engineers in Ireland, founded the Institution of Civil Engineers of Ireland. Some of the principles which he laid down in his inaugural address were quoted recently (in November, 1919) by Sir John Griffith, the then President of the Institution of Civil Engineers in London, as being of universal application.

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the defeat of 12,000 men (and 25 guns) with a mere handful of 700, and the final blows which ended the campaign. Later he commanded a division in the China War of 1860, and was the Commander-in-Chief of the Abyssinian Expedition in 1867–68. Yet I venture to think that not the least of his valuable services to his country was the work he did as Chief Engineer of the Punjab from 1848 to 1856, for the broad scheme of works, roads, canals, etc., which he then formulated, and for the fine spirit of devoted service which he seems to have inculcated in men like Sir A. Taylor and Sir J. Browne of whom I shall say something presently The " Nelson touch " has something analogous to it on our Frontier works.

Charles George Gordon was one of the most heroic men of the century, and while his fame is dear to all the nation, it is specially precious to us. Free from petty prejudice of caste or colour, he had sympathy with his fellow men as such, and his whole life was devoted to their service. The description of his character on his effigy in St. Paul's, reproduced in the replica here, is in the stateliness of its diction, and the truth of its description, incomparable, and I feel that to comment on it would be an impertinence. The nobility of his character, the purity of his motives, and the absolute unselfishness of his actions have gained for him a nation's deepest reverence and admiration. While some have criticised his actions, themselves perhaps of a school of thought hardly capable of estimating his character at its true worth, the strongest evidence in the attractive nature of the man lies in the fact that those who knew him best loved him most. I need hardly tell you of his great services first as a subaltern in the Crimea, then as a leader of victorious armies in China, then of his great work as an administrator in the Soudan, and his subsequent return there to clear up the terrible tangle of events at Khartum, resulting in his practical abandonment by our Government and his heroic death. One little incident I may tell, as it is illuminating. As you are aware, there are three statues of him, one in Trafalgar Square, one here, and a replica of the same at Khartum. When Li Hung Chang, the great Chinese statesman, was in London, he not only went to see the Trafalgar Square statue, but made the most profound obeisance to it.

In Khartum I was told that an old Soudanese woman, when she saw Gordon's statue, was convinced that he had really come back, and she spent some days waiting to receive from it the nod and smile she remembered he had always given her when he lived among them years before. What manner of man must he have been who thus elicited such devotion from a worldly old Chinese millionaire, and a poor old African woman ?

I have thus touched very briefly on the three greatest of our engineers in the XIXth century. There is one other whom I should like to have included in the list, and possibly there are those who

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consider him the greatest of all:—Sir Arthur Cotton. Of him I shall speak presently, in connection with a great change in our Indian policy, but for the present I would wish to speak about one whom I knew at the outset of my career—Major General, afterwards Field-Marshal, Sir Lintorn Simmons. He began his career in the Corps in 1837 and after being employed for some years in Canada, returned to England in the forties, and was employed as one of the Government engineers in connection with the railway development then taking place. He was the first Secretary to the Railway Department at the Board of Trade. In 1853 he got leave to travel in the East of Europe, where the political atmosphere was then cloudy, and where shortly afterwards war was declared between Russia and Turkey. He placed himself at the disposal of the British ambassador at Constantinople, who requested him to go to the Danube and report on the defences there and on the Turkish army under Omar Pasha. Simmons, who resigned his appointment on the Board of Trade, became military attaché to the Turkish army, and when in 1854 England declared war, he was placed in command of Turkish troops, taking part in the defence of Silistria and other operations in Bulgaria. He proceeded subsequently to the Crimea, and later with Omar Pasha to the east of the Black Sea to relieve the pressure on the Turks in Asia Minor. There he commanded a column which took the Russians in rear, and compelled them to retire with great loss. After the Crimean War he was the British representative on the Asia Minor Boundary Commission and later on he was Consul-General at Warsaw. Returning home in the early sixties, he was for some five years C.R.E. at Aldershot, one of our most important commands at all times, but especially then, when the mounted branches of the Corps were coming into being. Thence he came to the S.M.E. for some three years, and after that went to Woolwich as Governor of the R.M.A. There he remained for six years and thence he went to the War Office as I.G.F. At the time of the Treaty of Berlin he was military adviser to the British representation. Later he became Governor of Malta, and later on Special Envoy to the Pope.

This is a very brief outline of his career. I first came into contact with him—if I may use the expression without prejudice to the immense difference between us—when I joined the R.M.A. as a cadet nearly 50 years ago. He was then in the prime of life, a vigorous, active man, with bushy eyebrows, bushy whiskers and huge red moustache, and a strong, kindly face. I think we all knew that, though he was evidently a man to be feared, he was thoroughly in sympathy with high-spirited lads, and had no wish to force discipline to the point of harshness. Discipline he certainly put first, and we learnt that if we learnt nothing else. But in all essentials he kept his hand on the helm, he did not interfere with the instructors, but he was often in the class rooms to see what we were doing. I remem-

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ber too, he advised us all to go up for the Staff College as early as possible, and to get to know about other arms. To some of us he was more than the distant functionary who ruled over our lives. I was privileged to dine with him one night, accompanied by another cadet, and we got him after dinner to tell us some yarns about his experiences with the Turks. It was all intensely interesting and told without any personal swagger and yet with some very human touches which very definitely thrilled our enthusiasm.

There were two important occurrences—as they were very dissimilar, I can hardly call them anything else—at that time at Woolwich in which the Governor was concerned. One was the great fire which destroyed the fine central buildings. I remember him distinctly directing the salvage and fire extinction operations, and I think it cost him some self-denial to refrain from actually working a fire hose himself. The discipline of the cadets was good, and for that I think he certainly deserves the credit. The other event was the death of the ex-Emperor Napoleon at Chislehurst. The Prince Imperial was one of the cadets and naturally Sir. L. Simmons was a somewhat prominent figure in the ceremonial which followed.

When he became I.G.F. the influence of the Corps was very high. He was the valued counsellor of successive Secretaries of State and of the Commander-in-Chief, with whom, however, he did not always agree, stating his opinions very freely. On one occasion, when as a subaltern I was in charge of the Lower Thames defences at Gravesend, the Duke and all the Headquarters Staff came for inspection, and as I accompanied them round the works I could not help overhearing a good deal of controversy. But I also remember how on that occasion the I.G.F. took me aside and asked me a lot of shrewd technical questions, not so much, as I think, to test my knowledge as to show in a kindly way, his appreciation of a young man's duty and his interest in it.

Sir Lintorn passed away in 1903, aged 82. A mural tablet was unveiled to his memory in the crypt of St. Paul's Cathedral by the Duke of Connaught in 1906, and in so doing H. R. H. described him as " one who has added lustre to the name and to the history of the Corps—a man of great force of character and great power of imparting it to those under him. I am convinced that the name of Sir John Lintorn Simmons, with his great individuality, his warm sympathy, and his high sense of duty, will ever be cherished in the annals of the R.E., and that all who follow in that distinguished Corps will always look up to him as a great example to the British Army."

Not very long after Sir Lintorn Simmons left the War Office, another great soldier statesman became I.G.F., Lieut.-General Sir Andrew Clarke. He spent the early years of his service in Tasmania, New Zealand and Victoria, making roads, wharves, public buildings, etc. He

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was Surveyor-General of Victoria, and a member of the Legislative Council of that Colony while still a subaltern. Coming home in 1859 after this long colonial experience, he was, after some ordinary Corps duty, made Director of Works at the Admiralty in 1864, largely owing to the influence of Mr. Childers, who had been one of his colleagues in Australia, and who had taken up a political career at home. This appointment Clarke held for nine years, discharging his duties with great success, both as regards technicalities and the policy of the works. It was a valuable appointment for one who, knowing so well the colonial and imperial needs of the country, had then to provide for naval bases, and afterwards as I.G.F. had to provide for their defence. In 1873 he was made Governor of the Straits Settlements, but shortly afterwards was selected to be Public Works Minister in India, the first person to be appointed to such a position, and, I think, the only R.E. officer who has ever held it. He had many important questions to consider and many difficulties to contend with, as indeed was inevitable. Railway policy was a pressing question. There were huge famines during his tenure of office. The Afghan War of 1878–80 must have absorbed much of his attention, for vast engineering demands were made and for these he had to provide. In 1880 he returned home, was made Commandant S.M.E., and in 1882 became I.G.F. There again war preparation had to be made for the operations in Egypt, and the engineering policy to be adopted there were matters of urgent importance. He left the War Office in 1886.

He was a far-seeing statesman and I think the following measures he adopted are worthy of note. As Commandant, S.M.E., I think it was he who initiated the training of selected officers in mechanical engineering at large workshops, such as Elswick and Derby, also the Railway Traffic work at the headquarters of our large companies. This policy has borne splendid fruit both in peace and war. Then Clarke's colonial experience led him to get sanction to open the doors of the Corps to young men from Canada and other colonies, and also at one time when large numbers of officers were required, from Cooper's Hill College, and the English universities. These various avenues of supply were excellent and the splendid work done by the officers who thus entered the Corps is the best justification for the policy. Then I think it was Sir Andrew who first foresaw the importance of the Firth of Forth as a naval base. Up to this day, practically nothing had been done to occupy or fortify it. It was certainly he who initiated the Inchkeith experiments which were of such value in coast defence work. Had he lived to the Great War, he would have seen Inchkeith bristling with guns and the Forth the greatest naval fortress in the Empire.

One other measure he adopted was not a success, though to all logical reasoning it ought to have been. When he was P. W. Minister

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in India, the flow of students from Cooper's Hill C. E. College had to be provided for, and Sir Andrew decided that irrigation and railways (with a small reservation) should be entirely officered by civil engineers, and that R.E. officers should henceforth be employed only on military works. The subalterns who were there on canals and railways were transferred to the Military Works branch. As most of these—myself among the number—were then on active service, there was no inconvenience, indeed it was a very favourable opportunity for making the transfer. At that time the Irrigation Department was officered mainly by a very notable group of R.E. officers, men whose enthusiasm for the work was as conspicuous as their technical skill, and with our young officers there was keenness and zeal, the service was popular and several bade fair to become good hydraulic engineers. But the supply of R.E. officers was cut off summarily.

Well, twenty years later, I went to India for a second tour of service and volunteered for any public works duty in the Punjab, expecting I would be employed on frontier railways, on which I had had experience. To my surprise I was sent to Irrigation—of which I knew next to nothing. Then I found that the department was in a bad way, utterly unpopular with young civil engineers, with a poor standard of efficiency because it was with the greatest difficulty anybody could be induced to go into it. I was kindly welcomed, though it was evidently a matter of surprise that I volunteered for it. Discussing the matter with some of the senior civil engineers whose experience went back prior to Sir A. Clarke's day, I was interested, but very sorry, to learn that they all deplored the step he had then taken—natural though it was—for they said that the loyalty and co-operation which was a matter of service tradition with the R.E. officers had gone, and apparently no new bond of union had taken its place. The soul of the department had somehow departed. The withdrawal of the R.E. from the canals was therefore a loss to the country. And this fact is one among other proofs that the R.E. are too valuable to the nation at large to be *entirely* utilized in peace time on purely military services. The usefulness in war of men employed, during peace, on civil works has been proved again and again, while the cramped and limited nature of most military works tends to dwarf and discourage energies which might be and which ought to be used to national advantage in a wider degree.

I would like to tell one anecdote about Sir Andrew Clarke before leaving the subject of his character. I had at the beginning of the Afghan War got into a pretty serious scrape—I need not tell you what it was, except to say that I am not in the least ashamed of it, though it nearly involved a court-martial—and I was severely reprimanded. I met Sir Andrew here after the war was over, and he

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told me that though he had to join in the reprimand he would have acted, had he been in my shoes, exactly as I did. I mention this, for it was a kind act on the part of a General to a subaltern and also it shows how he recognized that at times the letter of the law is at variance with the conclusions of equity.

Mention of irrigation now leads me to consider the career and character of one who was the father of that scientific branch of the Corps activities—General Sir Arthur Cotton, one of the greatest hydraulic engineers of this or any other country. Indeed, so great were his achievements, whether we consider the colossal character of the works he built, or the number of lives he saved from famine, or the riches which his skill secured for the country, that we might well, as I have already said, include him in the list of the greatest of our Corps. In character he was a man like Gordon, with whom I understand he was in correspondence when the latter was in the Soudan. Like Gordon he was noble, unselfish, self-denying, he sought neither riches nor honours, but the welfare of the poor, the raising of the fallen, the glory of God. Like Gordon, he was not beloved by the politicians, who treated him, even after he had achieved startling success, with the gravest discourtesy, because his views did not accord with their policy. So little indeed was he known in this country that in the brief obituary notice of him in *The Times*, all that was said of his marvellously beneficent career was that "he was employed by the P. W. D. on the making of roads, the construction of bridges and other engineering works." These last words are truly delicious. The "other engineering works" included a dam or weir across a huge river four miles wide! His life was a long one, for he died in 1899 at the age of 96, and that, too, in spite of the fact that he seems to have been in delicate health in his early career and frequently obliged to leave his work to recruit. His first essay in irrigation works was the construction of weirs across the Cauvery river in Tunjore in the extreme south of India. There by his skill in adapting old and constructing new works, he transformed a poverty-stricken district into a fertile and prosperous land, which in the days of subsequent famines was always beyond all fear of scarcity. But his greatest work was some years later, in the forties, when he built a barrage or *anicut* across the Godaveri river at the apex of its delta. The river here is four miles wide, the bed is sand of unknown depth, the volume of water three times that of the Nile at Cairo. By utilizing certain islands, Cotton reduced the length to $2\frac{1}{4}$ miles—long enough in all conscience—and he so spread his foundations that they rested on the sand, with perfect success. The cost of the work was ludicrously small, only £50,000 approximately, and of course the benefits to the people in the delta of this great river were and are enormous. Moreover, it was the precursor of other great irrigation works, which in spite of some errors in

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alignment, etc., are now an asset of stupendous value. When I left India, one of the largest of these canals, in the Punjab, was paying a clear revenue of 20 per cent. *i.e.*, the difference between the revenue of the irrigated land and of the same land unirrigated, while the value of the crops in one year alone on that canal exceeded the entire capital outlay. In all India generally the net revenue gained was 11 per cent., and I think is greater now. But of course *the* gain to the country lies in protection from famine, and that, according to Cotton, was never done properly as it ought to have been. He was a tremendous advocate for navigation canals as against railways. Most people think he carried his views to excess, and that railway development was at least as important as inland water transport. On such a subject there must be great differences of opinion, but it is at least questionable whether the views of so successful an engineer as Cotton received anything like the consideration his eminent services entitled him to receive. In 1874 he came to lecture here, and I remember well his dignified appearance and the eloquence of his appeal to us young officers. The mass of statistics which he gave us was far above us, but he did give us some food for thought which I have never forgotten. He said the prosperity of a country depends on production and distribution, that one is of little use without the other, and that if you have large rivers you can use them to *both* accelerate production, *and* effect distribution. Railways cannot produce, they are a means, and that a costly one as compared with navigable rivers, of distribution. (We have seen in the Great War how in Mesopotamia the inland water transport was far more important than railways.) Talking of transport, he spoke of the bicycle which was then the plaything of the comparatively rich, and he prophesied that before long it would be the useful machine of the working man who would use it in going to and from his work, an idea which at the time seemed absurd, and yet came true in a very few years after. It is interesting to remember all this at a time when motor transport is introducing new factors into the problem and making our old roads, which fifty years ago were little used, now once more of increased importance. I also remember that at the close of his lecture, the old man spoke somewhat as follows :—" Some of you are going to India and will be employed on irrigation work. You will find it, though arduous, intensely interesting, and you will have the great satisfaction of knowing that the work you are doing will benefit tens of thousands of your fellow creatures, who will bless the unknown Englishman who has brought food and comfort into their lives. What nobler career can any man desire ? " In after life I had a little opportunity of testing the truth of these words and I realized their nobility, pathos and priceless value.

Sir Arthur Cotton was the precursor of many noble officers of our Corps who devoted their lives to the service. Of them I shall only

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mention one who, so to speak, transferred the splendid traditions of this school of work to another country at a most critical moment in its history and thereby turned the scale in a national problem of exceeding difficulty. This officer, Colonel Sir Colin Scott-Moncrieff, was a very near relative of my own, and I feel a good deal of difficulty in speaking about his services impartially, for the family ties which associated us may lead me to take a biassed view of his worth. He was, like Cotton and Gordon, a most enthusiastic champion of the poor man, the ryot of Madras, for whom he toiled night and day during the great famine of 1877–78, and the fellah of Egypt, whom he redeemed from the slavery of the *corvée*. I think, too, that most officers who served under him would agree with me (who never served under him) that he was one of the kindest and most unselfish men they ever met. His association with Egypt was, humanly speaking, a matter of chance. He had retired from the service after some 25 years of useful and honourable work in India, and he happened to be going home by the usual Red Sea route, instead of by America, "at a loose end," as we say colloquially. At Suez he got a telegram from Lord Dufferin, who was then at Cairo, asking him to come and see him. It was just after the 1882 campaign and Britain had to reduce order out of chaos. Lord Dufferin, who was the British representative, asked Colonel Moncrieff to tackle the irrigation problem there, and he thought he might as well do that as go home and take up some other philanthropic work which he then contemplated.

So he took the job in hand and in the teeth of much professional opposition made the shaky old French barrage at the Nile delta do its duty—which it had never done—brought a chosen band of officers from India who made corruption and tyranny flee away, and finally in the teeth of tremendous international obstruction he abolished the *corvée* or forced labour, an iniquity which had ground down the poor since the days of Pharaoh. He then left Egypt and for several years was U. S. for Scotland.

Later on in 1901–02 he was the head of a Commission which enquired into the whole possibilities of irrigation in India—a most exhaustive task, but one which meant a sound and settled policy for future guidance—a magnificent monument to leave behind him.

I now come to speak of two officers whose lives, whose characters and whose work were very similar—General Sir Alexander Taylor and Major-General Sir James Browne, commonly known on the frontier and in the Corps as "Buster Browne." In fact there is a rather amusing story told about this nickname. He was dining at Simla with the Viceroy, and before dinner the wife of that distinguished official was told by the Military Secretary that "Buster Browne" was going to take her in to dinner. She thought it was his name, the Military Secretary never for a moment imagining that

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she did not know a man so famous. She addressed him throughout the evening as " Sir Buster " to his huge delight.

Both Taylor and Browne were educated abroad, the former at a very remarkable school in Switzerland where the lads were taught—rather like modern boy scouts—to seek for opportunities to do service to their fellows. Browne was the son of a Scotch father by a Dutch mother, and his early education was almost entirely in France and Germany. Both these great engineers learnt the chief lessons of their life on the N.W. Frontier, developing Lord Napier's great schemes, for Taylor was the disciple of Napier, and Browne that of Taylor.

I only knew Taylor slightly, and can therefore only give you an account of him at second hand, but as I used to hear much of him from Browne, who was my chief officially, and a great friend personally, I got to know about him fairly intimately.

He went to India in 1845, and served in the two Punjab campaigns with great distinction, including the conveying of the siege train some 250 miles by pontoon rafts down the flooded Sutlej to Multan, and then being one of the most prominent leaders of the attack on that fortress. In these campaigns he came into close touch with Napier, who appointed him, after the war was finished, to take on the important work of constructing the Grand Trunk Road from Lahore to Peshawar, over 200 miles of exceedingly difficult country. It was a very responsible task for so young an officer as he then was, but Napier knew his man. For something like eight years Taylor was employed on this huge and intensely interesting task. Then came the crash of the Mutiny. That period of our history still awaits some Homer to describe it in epic poetry, and to depict the heroes of the tremendous drama. John Lawrence ruled the land from Rawalpindi, stamping out sporadic cases of rebellion, with Herbert Edwardes at Peshawar guarding the frontier from Afghan intrigue and hostile tribesmen. Yet all the time Lawrence had his gaze on Delhi, the nerve centre of the whole rebellion. He sent off every soldier he could spare under John Nicholson, but he knew (what was apparently forgotten in 1914) that in a war of positions you must have engineers of the best, and as Napier was at home on leave, he sent off Taylor, in the hottest of a Punjab summer, to go to Delhi and there supplement the efforts of the Chief Engineer, Richard Baird Smith. This capable and resolute officer was the backbone of the attack, but he was utterly prostrate with sickness. The General in command was a nonentity, but his A.A.G. was Neville Chamberlain, a great soldier, and Nicholson had by that time arrived to strengthen the brains and heart of our army. The power of this little force lay mainly in its resolute leaders, and their daring policy. The enemy, vastly superior in numbers, ammunition, equipment and position, had no leaders, and was therefore weak. It is a little difficult, without going into

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long details, to show how daring and clever was the scheme which Baird Smith and Taylor evolved. Broadly speaking, they had before them a strong front of a bastioned system held by superior numbers, who also occupied outposts and advanced positions beyond the permanent works. We had a secure flank on the left, furnished by the river Jumna, and we had a fairly good position held by our troops on the right. But anything like a formal attack with parallels and trenches was quite out of the question. The only chance of success was the construction and arming of siege batteries very rapidly in absolute secrecy and with complete surprise. To do this demanded careful reconnaissance, the fullest detail of preparation, and the absence of any movement that would rouse an enemy's suspicion. In collaboration with Chamberlain, Nicholson and his bed-ridden chief, Taylor worked out the whole plan. Alone and at night he penetrated the hostile outposts, fixed the position of the batteries, brought up the guns for the false attack, and then the assaulting columns for the real blow. How brilliantly successful it was—albeit the victory was dimmed with the loss of John Nicholson—is a matter of history. It was the turning-point of the war and the restoration of British rule. After the capture of Delhi, Taylor went on to Lucknow, where he found himself once more under Napier, to their mutual pleasure. Once more he led an assaulting column in the tremendous fighting which took place there, and once more he was wounded very severely this time. He returned to England after the campaign, after 13 years absence, with a splendid record as a soldier, even in those days when war had brought many fine men to the front.

He was offered several important military commands, and if he had been actuated by selfish motives, he might certainly have risen to a very high position in the purely military line of our profession. But it is characteristic of the man that he went back to his great road, saying that to leave it was like deserting his wife for a richer woman. He knew so well what had been done and what was still remaining that he felt no other officer could take his place adequately and bring this vitally important work to completion. So for many years after the Mutiny he was back at the great work, which he finally completed. During these years the Umbeyla campaign took place, and he was C.R.E. in the thick of the fighting again, and again wounded. Later in his career he acted as Chief Engineer of the Punjab, later on he was employed at Headquarters on Defence work, leaving India about 1880. Later on he was Principal of Cooper's Hill College.

"Buster" Browne joined him on the Grand Trunk road in the early sixties. He had arrived in India in '59, went straight to the frontier on one of the many Waziri expeditions, and at once took to the frontier life with natural zest. He was a man of herculean

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strength, boyish humour and a rich talent for adventure, so he soon became the leader in all sorts of exploits among the frontier tribes. Just to mention one of his exploits, when with the outposts in the Umbeyla campaign he used to imitate with singular success the voice of one of the enemy's mullahs or priests who called the faithful to prayer at the orthodox hours. Browne mimicked him with such accuracy that the enemy were aroused to their devotions with such frequency and irregularity that the exasperated priest challenged him to single combat. He had more than one such combat in the hot fighting of that campaign, he was severely wounded twice, but he ended with a fine reputation as "a bonny fighter" even among the frontier regiments where that sort of fame is common.

About 1864 he went as professor of mathematics and assistant principal to the Thomason College at Roorkee, where he found that teaching others is by far the best way of teaching oneself, and that (for a short time, anyhow) a period of instructional work in the course of a practical career is of extraordinary value. But he only stayed on this work for a short time, going on to the construction of an important hill road in the Punjab, where he was for about five years. There he designed and built some very remarkable bridges—some of them indeed the largest of their kind in the world—brick arches of 140-ft. span from bricks made in his own kilns, and a concrete arch of 80-ft. span, and some remarkable timber and suspension bridges. On return to England (where he was awarded one of the medals of the Institution of C. E. for his road work), he went on a long tour of examining works abroad, in Holland, among some of his relatives, investigating river training and coast protection, and in America for a year and more, studying bridge design and construction. On return to India he was detailed to prepare designs for a railway bridge over the Indus at Sukkur. He worked out an elaborated suspension bridge, but, much to his disgust, his plans were superseded by the hideous cantilever which now spans the river. Later on he was sent to investigate the possibilities of roads on the Baluchistan frontier, then little known, and to start work at Quetta. Here he had more choice adventures. He was a clever linguist, and went among the tribes often in native dress. He had a wonderful influence among them, largely due to the extraordinary fact, which he found out some years later, that he had a double, a mullah of great celebrity. Even so it is marvellous that he escaped being murdered.

The intimate knowledge he thus acquired of this frontier and people led to his being appointed to be political officer with the first troops that went that way in the Afghan War of 1878–9. In this duty he was very successful, his most notable feat being the capture, single handed, of the Afghan fort of Khelat-i-Ghilzai by a piece of sheer audacity. After the first part of the campaign he

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guided a column back to India by an unknown route and then, thinking as we all did that the war was over, he returned home and thus missed all the big fighting in the second part. On return to India he was for a while on special duty at Simla where I first met him. Then the Egyptian campaign of '82 broke out and he went as C.R.E. of the Indian contingent, with more amusing adventures at Tel-el-Kebir and elsewhere.

Then came the biggest task, even of his eventful life—the construction of the Sind Peshin railway, in which I had the privilege of being his personal assistant and staff officer. It is 36 years since, in this theatre, I gave three lectures about this railway—crude lectures they were, but they were the first I ever delivered. I have, of course, no intention of going over the story again, but I think I may quote what others have said about the work, as the mere description of the difficulties and results show what manner of man he was who overcame them. The length of the line is 215 miles, rising from Sibi on the edge of the Sind desert at 400 ft. height to a summit level of 6,600 ft. in 112 miles. The ruling gradient is 1 in 45, limiting curvature 600 ft., gauge, 5 ft. 6 in. This is longer than any two of the Swiss Alpine railways put together, and among them the highest summit level is 4,400 ft. Moreover, they cost on an average £30,000 per mile exclusive of special tunnels, while the Sind Peshin line cost under £20,000 a mile, all told. Moreover, the latter took only three years to construct as against far longer periods in the others. The Ceylon mountain line, about 120 miles, I think, took 11 years. As regards the country, the following is an extract from *Engineering*:—

"It traverses a region of arid rock without a tree or bush, and with scarcely a blade of grass; a country on which nature has poured out all the climatic curses at her command. In summer the lowlands are literally the hottest corner of the earth's surface, in winter the upper passes are filled with snow. The few inhabitants are thieves by nature and cut-throats by profession and regard a stranger as a gamekepeer does a hawk, something to be bagged at all costs. Food there is none, and water is often absent for miles, timber and fuel are unknown and desolation writ large is graven on the face of the land." Then there were difficulties of cholera and other sicknesses, floods and landslips, but above all the pestilent worry from the petty jacks-in-office in Simla. Then another rival line was started up the Bolan Pass, and for months and even years the daily press kept on carping at the R.E. who were said to be extravagant and inefficient, as compared with the civilians who were running the other. "Buster" Browne never said a word in his own defence, and, in fact, when my lectures were published and I came in for my share of abuse and asked him whether I should reply, his reply was brief—"Let the pi-dogs howl." Twenty years later I went up one pass and down the other. The Bolan line had been absolutely wiped

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out, there was practically no vestige of it. Of the other, all, certainly 95 per cent., remained as my chief had built it.* It was of thrilling interest to go over the line again and see all the marks of his mighty genius graven in the rocks and gorges of that grim country where I had known tens of thousands of busy men blasting and building, and where now all is silent as the grave save when each day a train goes thundering past.

"Buster" Browne and I lived in tents together, and naturally got to know one another very intimately, an intimacy which warmed into very great friendship. He was a most amusing companion, full of humorous yarns, and with a very varied amount of useful information. Personally one of the most generous and unselfish of men, with deep religious feeling underlying his practical exterior, he was ever mindful of the honour and dignity of the Corps and the respect due to all ranks. Especially was he interested in the young officers sent to us, in considerable numbers, from home. He called them his "young bears learning to dance; the hotter the plates, the sooner they learn," and certainly the plates were hot enough! When I think of these officers and remember how many have distinguished themselves since—Sir Fenton Aylmer, Sir John Capper, Sir Ronald Macdonald, and many others—I realize the soundness of his forecast as to their future. One of his favourite mottoes was *Ex arduis ardor*, which he translated "Harder by hammering," and certainly it was one which was then put to a crucial test.

One of the schemes which we often discussed was the placing of all works on the frontier under the R.E., which actually came into being five years after his death, and I feel sure he would have been interested and pleased that his old staff officer was the first head of the new organization.

After a period of leave at home, Browne went, at Lord Roberts' request, to be Q.M.G. in India, the first R.E. to be so appointed. It was a strenuous time, for there were numerous frontier wars and much re-organization. After a few years in that post he went to Quetta as Chief Commissioner in Baluchistan, to an arduous and difficult task, and I think the work was too heavy for him. At all events I was much distressed at the tone of his letters; he appeared to be so overwhelmed with the iniquities of the unruly chieftains of that wild land, and the failure of support from Government to his proposals. And there he died, suddenly, in June, 1896.

* It is only fair to state that the Bolan line was not intended to be in all respects permanent. To the best of my recollection, a phenomenal rainfall had just occurred, and the line was constructed with the experience gained, so as to be above the *normal* level. But apparently in subsequent years this did not prevent its entire destruction.

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The picture of him in the Mess is quite inadequate in giving an idea of the man, although it was painted (from a photo) by a very good artist. On the other hand, that of Sir Alick Taylor is excellent, giving a charming idea of the courteous and modest gentleman he was. There is at Delhi a bronze statue, erected by a Committee, of which Lord Roberts was president, and I had the honour of representing the Corps. It is right that there, of all places, there should be a statue of him who played so conspicuous a part in the capture. In Rochester Cathedral there is a tablet to Sir James Browne, the inscription on which, at Lady Browne's request, was composed by two of his friends, General Henry Brownlow and myself. But his best monument is carved on rocks and tunnels, on the great frontier railway which he built so successfully.

I have now come to the end of my task. Had time allowed, I should like to have said a little about another great engineer, Sir John Ardagh, whom I knew and deeply admired. He was Commandant here at one time, the best I ever served under. He and "Buster" Browne were men of very different types, but they knew and appreciated each other well, and they were imbued with the same chivalrous spirit. More I am afraid I have not time to say.

I would, however, conclude by saying that great as are the examples of the past, I am not the least apprehensive of the future. I used, in the days when I was an instructor here, 25 years ago, to hold that the young officers of that day were splendid, the very cream of our nation's manhood, and all we seniors had to do—and it was a huge and difficult task—was to use this material wisely and to train it properly. The records of the Boer War show how gallantly and well our young officers behaved, and the Great War has still further confirmed the good opinion that I held of their value. It is in the firm confidence that you will uphold the great traditions of the Corps that I commend to you the fuller study of the biographies of the men whose careers I have briefly touched upon, and of others of similar calibre, and I am sure that you in your turn will add lustre to the great reputation of your ancestors, and will pass on to your successors an enhanced heritage of noble deeds and high example.

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THE INFLUENCE OF COLOUR ON THE HEAT-ABSORPTION OF PAINTS AND BRICKS.

By MAJOR C. R. SATTERTHWAITE, O.B.E., R.E.

SOME interesting experiments on the influence of colour on the amount of heat-absorption of various materials in hot sunlight were carried out in the Soudan during the period 1915–1918, by G. W. Grabham, Esq., M.A., F.G.S., and are described in an article in the *Journal of Hygiene*, Vol. XIX., No. 3, January, 1921. The experimenter's attention was particularly concentrated on the properties of various materials and fabrics used for clothing; but he also carried out tests on painted surfaces and bricks.

The experiments on paints are described as follows:—

"For the purposes of experiments, cylindrical tin flasks 12½ cm. long and 7½ cm. in diameter were adopted. They were provided with necks to accommodate corks, through which thermometers were inserted so that the bulbs were placed freely at about the centre of the flasks. The flasks were laid on their sides, and in order to give them stability a four-ounce volume of clean sand was measured into each. The amount of sand was not enough to come in contact with the thermometer bulb, and, as the quantities were similar, it can hardly have influenced comparison of the temperature effects due to the paints.

"The principal experiments were conducted at Halfa in 1916. The flasks were laid out on a white sheet resting on a doubled woollen blanket to eliminate as far as possible disturbing factors due to heat absorption by the surroundings. They were set out at intervals of about 30 cm. between them, and arranged in order of their apparent tints so that the lighter-coloured flasks were next each other and distant from the darker ones. These precautions were taken to reduce effects due to radiation from one flask to another, such as might have interfered had a black flask been near a light-coloured one. Both the Soudan Railway Department and the Public Works Department kindly undertook the painting of sets of flasks with colours in common use. Besides the immediate interest of testing such colours, there was the advantage of having them applied by the very workmen and in the same way as in ordinary practice.

"Standards of reference were provided by other flasks, the white being coated with a lime-wash which gave a dead-white surface, while the other was coated with a mixture of lamp-black and varnish which dried with a dull black surface."

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The results of the tests are given in tabular form, showing the temperatures at intervals during the hot period of the day. It is sufficient here to give the mean temperatures.

P. W. D. Paints, Halfa, 15. 5. .16. *Maximum temperature in official screen,* 44° *C.*

Paint.	Mean Temperature °C.
Black standard	69·5
Cement wash	65·3
Bright red	62·2
Dull red	61·9
White enamel	54·7
White standard	52·0

Soudan Government Railways Paints, Halfa, 2. 6. 16. *Maximum temperature in official screen,* 40° *C.*

Paint.	Mean Temperature °C.
Black standard	62·9
Black paint	62·5
Brown paint	61·4
Green paint	60·4
Grey paint	58·7
Khaki paint	57·3
Scarlet paint	54·4
Straw paint	52·7
Cream paint	51·0
Cream enamel	50·8
White enamel	49·1
White standard	45·3

From the mean of several observations a further table is compiled, the most interesting facts in which are that with the "White Standard" (lime-wash) at 46·6° C. or 115·9° F. the following colours showed an excess temperature over the white standard as under :—

	Excess °F.
Cream paint	11·5
Khaki paint	22·5
Cement wash	26·8
Black paint	35·2

Technical descriptions of the paints are not given, but the section dealing with paints concludes as follows :—

"By the kindness of the late Mr. E. W. Buckley, of the Irrigation Service, a practical test was made by whitewashing the half of the galvanized corrugated iron roof of a barge, the other half remaining in the usual condition and presenting the ordinary, rather dull appearance of the weathered metal. In the sunshine of the middle hours of the day the difference between the temperatures of the two halves was very striking. The plain metal became so hot that the

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hand could hardly bear it, while the whitewashed part remained cool and could be handled with comfort. The roof was low and in moving about under it, the radiant heat from the plain half was immediately felt as oppressive and showed the need of a helmet. Beneath the whitewashed part, on the other hand, it was possible to remain bare-headed with comfort. An attempt on one occasion to measure the temperature gave 45½° C. and 33½° C. respectively for the plain and whitewashed parts, but little importance is to be attached to these figures, as that relating to the plain part is almost certainly too low. They indicate, however, the magnitude of the difference. Owing to the oppressive temperature, the iron roofs of a number of similar barges have been lined with wood, but as efficient a result might have been attained by means of a coat of white paint, or even whitewash, so long as the latter withstood the rains."

The experiments on bricks are thus described :—

" In February, 1915, some building bricks were tested on the same lines as adopted with the cloths and paints.

" Both sun-dried and burnt bricks are in use in the Nile Valley, and the coolness of mud houses as compared with those of burnt brick is common experience. For the purpose of the experiment a hole was drilled from the end so that when a thermometer was inserted it was placed about the centre of the brick. The thermometers were packed round with fine soil to keep them in place and preserve the records from disturbances due to convection. A pair of burnt bricks and a pair of sun-dried ones were used and one of each pair was left plain while the other was whitewashed. They were laid out on a board at 9 a.m. on February 9th, 1915, and not disturbed until after the readings on the next day. The following are the readings at 2 p.m. on the two days :—

	9. 2. 15.	10. 2. 15.
Plain burnt brick	57·8	53·3
Plain sun-dried brick	54·3	50·4
Mud brick, whitewashed	49·5	46·9
Burnt brick, whitewashed	48·3	46·3
Official maximum	33·4	31·1

" Possibly the hotness of the burnt brick as compared with the sun-dried structure is not due to the greater absorption alone, but also to its texture. The firing must result in the grains being in more intimate connection than is the case with the sun-dried one, with the result that the burnt brick takes up more heat during the hotter parts of the day and radiates it more freely in the evening. The same kind of effect is experienced in the open country. Where the desert surface is formed of loose sand, the surface cools quickly and the nights are comparatively cool even in the hottest seasons. Where, on the other hand, crystalline rock predominates, the solid stone absorbs a large amount of heat and appears to be able to radiate it

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during most of the night so that these are sultry and oppressive. No figures have been obtained for these conditions, but if the hand is thrust into an exposed sand dune on the afternoon of a sunny day, the heated surface layer will be found to be only about 10 or 15 cm. thick and quite cool sand will be found just underneath."

The experiments conducted on cloths were exhaustive, and gave results indicating a pronounced superiority for white linen or cotton fabrics over all types of khaki. In general it was found that the temperature of khaki fabrics, when exposed to sunlight, exceeded that of white drill by 10°–20° C.; while thin black fabric showed an excess of over 30° C. over white drill.

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ANTI-AIRCRAFT SEARCHLIGHT DEFENCE.

A SUGGESTED SCHEME FOR RAPID TACTICAL SEARCHING.

By MAJOR H. J. HUMPHREYS, R.G.A.

IN Field Service Regulations, Volume II. (Operations), 1920, Chapter XI, Section 140, para. 2, we are told that " Units of Anti-Aircraft Artillery, Engineers with Searchlight Signal Troops . . . will be organized to deal with air attacks on communications, rear concentrations, and dumps."

Considering the general form of warfare as seen in France in 1914–18 the organization of this A.A. defence, facilitated by siege warfare, was slowly and methodically built up.

In a war of movement a hasty defence is not so easy to arrange.

" Every body of troops, when halted, will be protected by outposts, in order that it may rest undisturbed." These words are to be found in Section 90, but they do not refer to attack from the air. It is not too much to expect in future warfare that, in addition to outposts, some form of A.A. defence will be necessary for troops, parks of ordnance, food, and other stores, even when such troops and parks remain halted for a very short period. Time to organize such defence will be short, consequently it cannot be expected that an elaborate organization can be accomplished. The A.A. units of Artillery, Lights and Signals will have to be employed tactically and a hasty *protection organization* devised.

The posting of Artillery and Lights with the corresponding signal communication to suit the topographical surroundings, is a tactical problem, which can be quickly solved by the anti-aircraft defence Commander, but the question of fighting control is a much more difficult problem.

With fixed A.A. defences as existed in many places during the war, fighting control can be maintained with the aid of mechanical devices —but all mechanical devices require time to instal, and to test, and generally special cable to work from the controlling centre. Mechanical devices are not applicable to temporary and hasty defences. The control of lights offers a difficulty.

The following rapid tactical scheme for controlling lights is submitted for consideration, and to facilitate explanation an imaginary tactical situation is briefly described.

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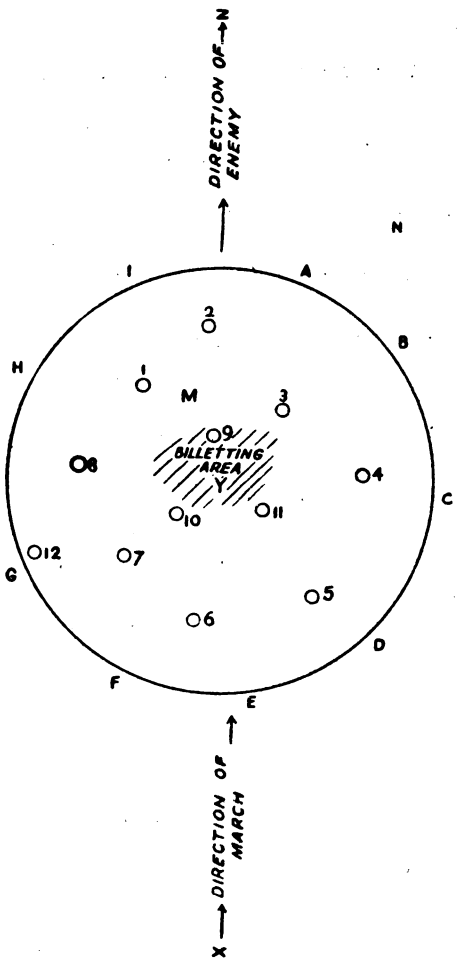
A force is marching towards the enemy northward from X to Z and halts for the night at Y—usual outposts are put out and the Anti-Aircraft Defence Commander proceeds to organize a defence. Assume he considers 8 guns and 12 lights sufficient.



He makes his reconnaissance and decides on the positions of his guns and lights and his own controlling station.

He issues orders accordingly, but before the R.E. officers proceed to their stations they receive instructions on the following lines :—

Each R.E. officer produces his map—an arbitrary circle is described enclosing the electric light stations, and arbitrary areas such as A B C are marked on its circumference. Very little time is required to do this.

Each officer marks his map in exactly the same manner as that of the A.A. Commander is marked.

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At each searchlight station the base of the projector is marked with chalk to agree with the orientation of the areas A B C, etc., as seen from the post.

Each searchlight has its name or number, such as 1, 2, 3.

Field telephonic communication is therefore required between the controlling officer and his guns and lights, but visual signalling is equally effective where the topography admits, as messages to be sent are short.

Action of Control.

Let us now consider what form the control takes in action.

At any moment the control officer desires the sky searched with light over a particular spot, say " M " He at once gives the order :—

No. 1 search C.
No. 3 search H.
No. 2 search F.

If, at the order " search," it is understood a methodical search is carried out a definite number of degrees right and left, up and down, there should be no position which could not be searched instantaneously at the will of the Controller.

A further example :—Suppose the Controller is suspicious of enemy aircraft in the direction of " N," he can order with an almost mechanical mind :—

No. 4 search B.
No. 2 search A.

It will be seen that this method of control is almost instantaneous and, above all, admits of concentration of lights.

Such orders as north, south, north-east, etc., could not be so easily worked—to commence with, the Controller would have to make a mental calculation, a troublesome thing in the excitement of action.

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HILSEA ORDNANCE DEPOT.

By COLONEL J. C. MATHESON.

OWING to an agreement, arrived at between the War Office and the Admiralty, the Ordnance Depôt at the Gunwharf, Portsmouth, is being handed over to the latter for the purpose of forming a shore establishment, to take the place of H.M.S. *Vernon* (naval mining and torpedo school).

The Depôt thus displaced is being re-provided at Hilsea, just south of the Hilsea Lines, and is rapidly approaching completion. It is really an expansion of certain Ordnance establishments which have been erected there previously, most of them being constructed between 1914 and 1918.

The principal constructions in the Reprovision Works at Hilsea which may provide points of interest are :—

(*a*) The equipment sheds.
(*b*) The workshops.
(*c*) Drainage.
(*d*) The married quarters for officers, other ranks and police.
(*e*) Main office.

(*a*) *Equipment Sheds.*—Three of these have been erected, each 400 ft. by 120 ft. The walls are of 4½-in. brick, strengthened every 12 ft. by buttresses which carry the steel roof trusses. The roof is of slate, and is in three spans of 40 ft. each, the trusses being supported by the buttresses in the walls and by brick columns. There are loading platforms, running the entire length of the sheds on each side, with railway sidings. The photo shows the interior of one shed. The floors consist of 3½ inches of tarmac rolled in three layers of different grades. This gives a warmer and drier floor than concrete, and is about 30 per cent. cheaper. The cost of these sheds has worked out at 4·17 pence per foot-cube, exclusive of overhead charges.

(*b*) *Workshops.*—These are of the latest factory type in brick with the usual north light, and have floors of either concrete or wood block, according to the nature of the work to be carried on. They are sited on three sides of a rectangle, with the administrative block at one end of the rectangle and the shops on the two sides with a large open space in the middle. They are equipped with the most modern plant, and power is supplied at 550 volts D.C. from the Portsmouth Corporation mains. The cost per foot-cube comes to

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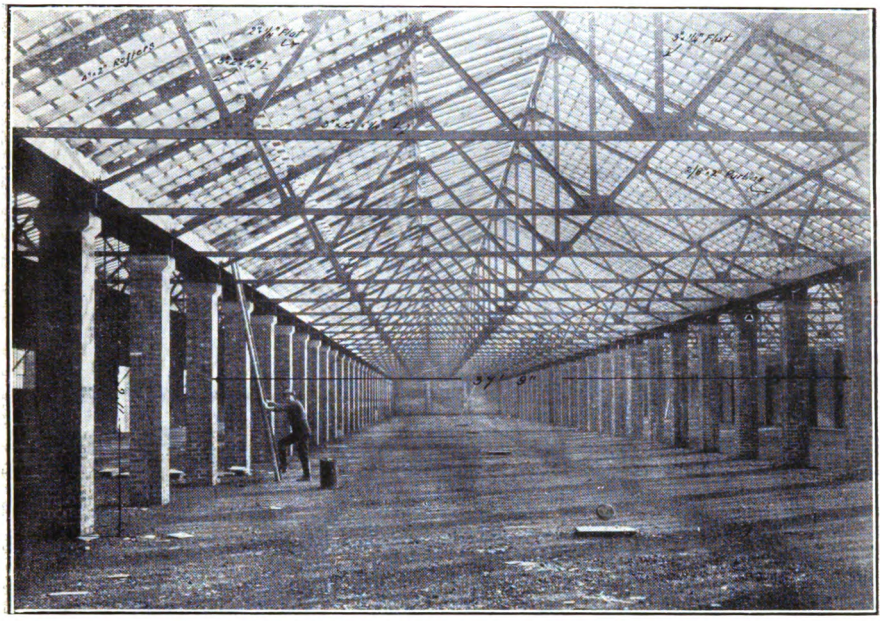
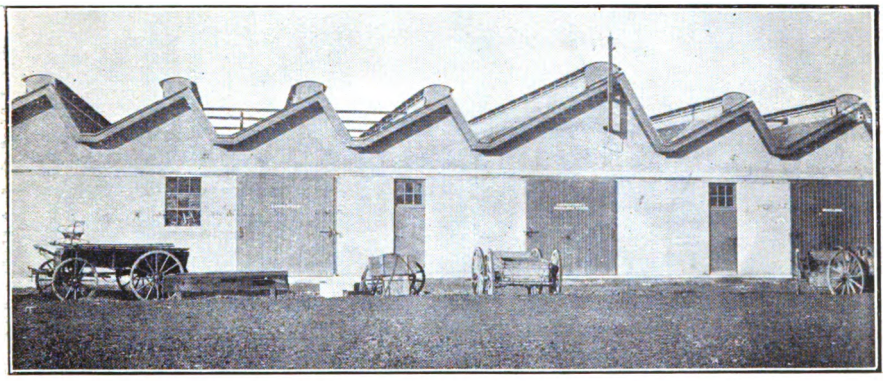
HILLSEA ORDNANCE DEPOT.



Interior of Equipment Sheds.



Workshops. Part East Elevation of West Block.

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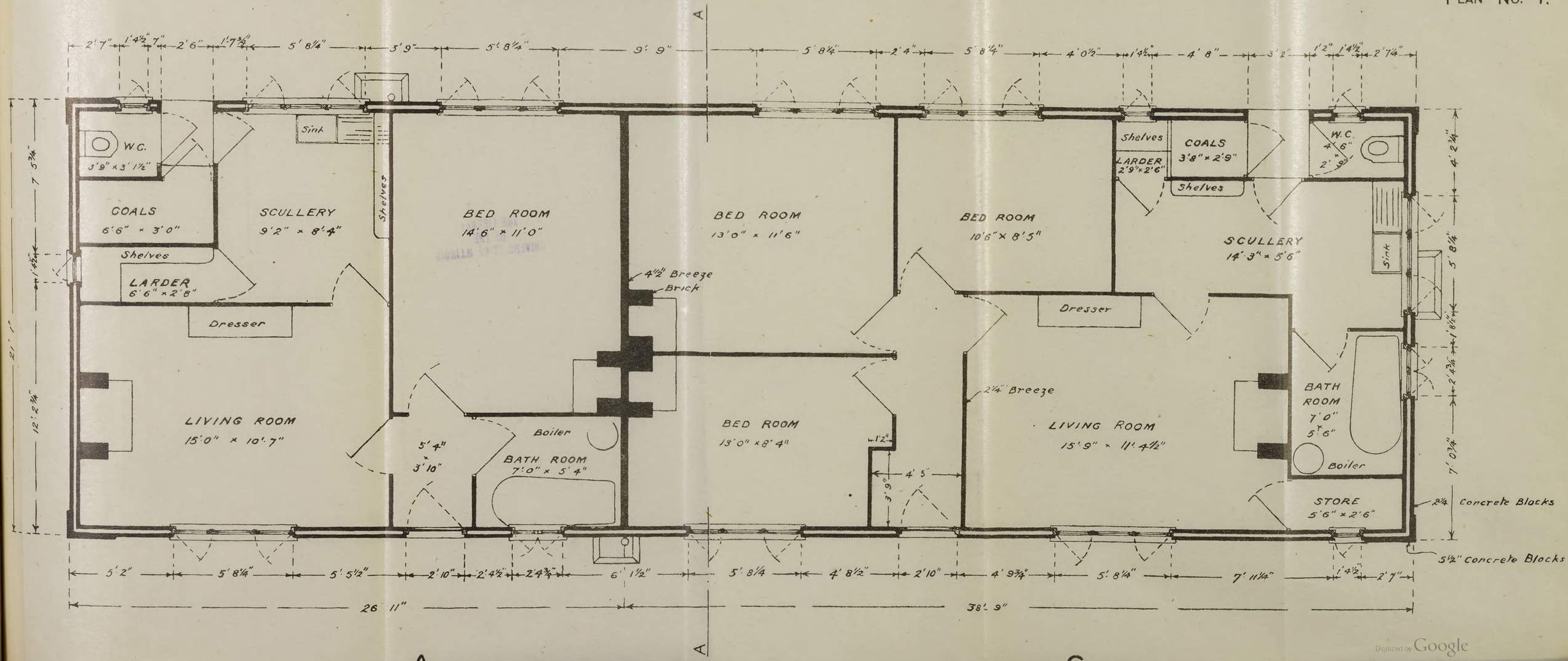
PLAN NO. 1.



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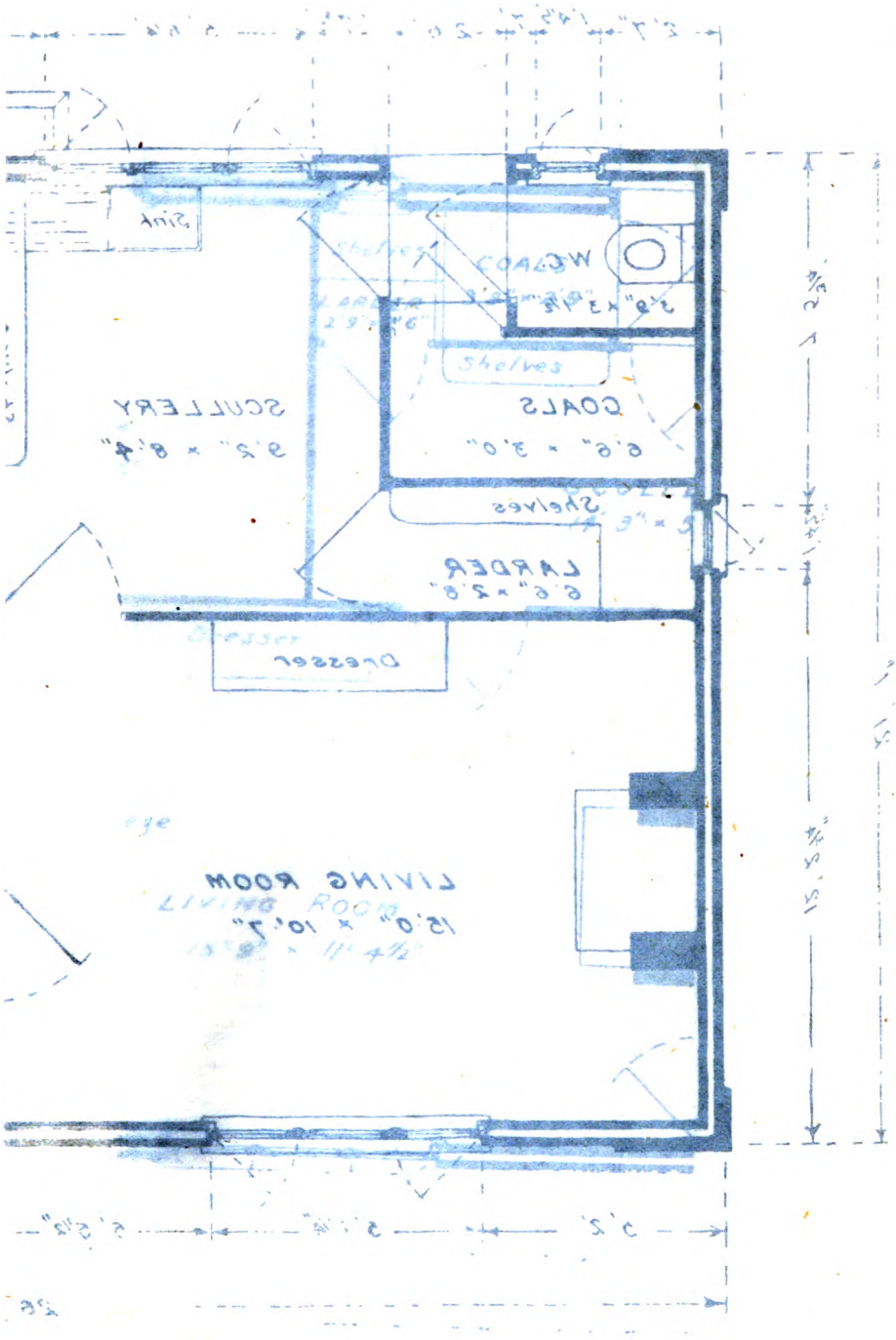

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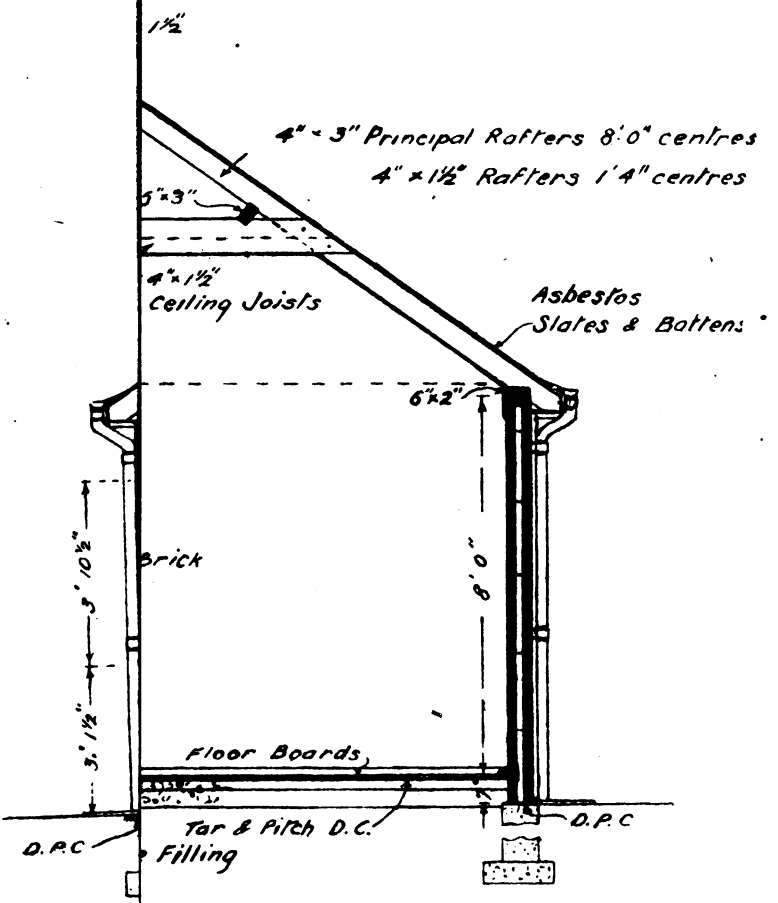
Plan No. 2.



A.A

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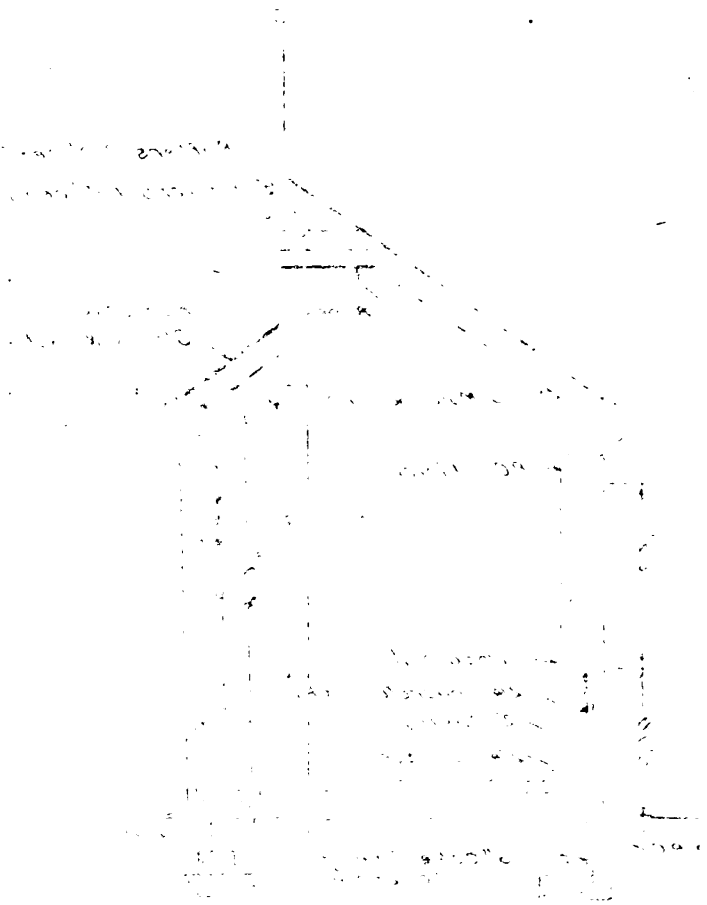

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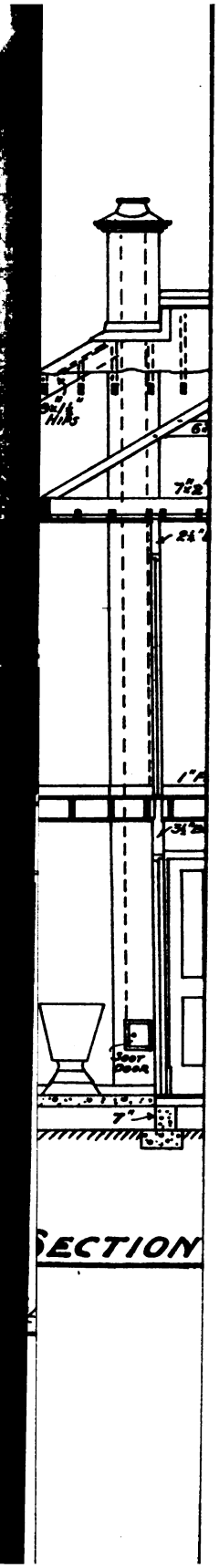

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9·76 pence. This includes all machinery, power, light, roads, drainage and making up the quadrangle between the East and West blocks. The photo shows part of the West Block.

(*c*) *Drainage.*—Owing to the fact that the site is very flat and low-lying it has been necessary to instal compressed air ejectors to lift the sewage at two different places. One lifts 12 ft., and the other 14 ft. The ejectors are of the same type as the *Shone*. There are two electric motors of 2 B.H.P. each for working compressors, and these are brought into action automatically when the pressure in the reservoir falls below 10½ lb. per square inch. The maximum pressure of one compressor is 15½ lb., and the other 16½ lb. The longest length of pipe (1½ in.) is 1,900 ft. At each lift 25 gallons are raised. The ejectors are duplicated to avoid trouble in case of breakdown. Considerable difficulty was experienced in constructing the ejector pits owing to the infiltration of tide water. The work was finally accomplished by excavating a deeper pit close to the ejector pit to act as a sump for a pump by which the water was kept down.

(*d*) *Married Quarters.*—The quarters provided under the scheme are :—

(a) 3 officers (one Group 3, one Group 4 and one Group 5) ;
24 married soldiers ;
5 warrant officers ;
1 police inspector, practically a Group 5 quarter ;
23 police, similar to warrant officers.

All these quarters, except the Group 3, are constructed in concrete hollow walls, the outer wall being made of hard concrete blocks, 18 in. by 9 in. by 3½ in., and the inner wall of breeze blocks, 18 in. by 9 in. by 3 in., with a 3 in. space between ; the two walls being bonded with the usual iron ties. The roofs are the ordinary wooden gable type, covered with eternit slates.

Both classes of block have a composition of 6 to 1, and were made in two ways, either in Winget machines or by hand in a locally made frame with partitions for 36 blocks. The Winget blocks were what may be called dry concrete, while those made in the frame were wet. Owing to the great dryness of the past summer on the South Coast the dry process blocks were not so satisfactory as the wet, and had to be watered daily while setting. This method of making blocks in a frame, although somewhat slower than the Winget process, may often prove of use in a large job, as it can be done at odd hours by men for whom it might be difficult otherwise to find profitable employment. The cost of these hand-made blocks at Hilsea at the present time is 6½d. each. Here they have been used in the officers' quarters, and in the main office block. The Winget blocks have been used for the other quarters.

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All the married soldiers' quarters are of the single-storied type, as illustrated on Plans I. and II. The cost of these, which were the first constructed, varies according to the type of quarter, of which there are two in each block. The cost of a block containing one "A" and one "C" quarter was £914.

One feature of these quarters is that the floorboards consist of converted "bed-boards" nailed direct into breeze concrete filling. This has the composition of 4½ to 1, no sand being used. The exact proportions require experiment for their determination, as they have to vary with the quality of the cement. The result of these floors appears to be satisfactory.

The warrant officers' quarters, and the police quarters are two-storied and have two quarters in each block as shown on Plan No. III. The cost of these has, so far, worked out at £815 per quarter. (£1630 per block.)

(*e*) *Main Office.*—This building, which measures 77 ft. 6 in. by 73 ft. 3 in., is of a special design, with a large central office, 41 ft. by 40 ft., for all the clerks, and small offices all round for the officers' offices, typists, etc. The whole is central-heated. This building is also of the concrete and breeze block construction with a ruberoid covered roof over the side offices and eternit slates over the central one.

The overhead charges on these Re-provision Works have amounted to 6¼ per cent. This includes :—

Pay of superintending officer, foremen, clerks, etc.
Rental of office buildings.
Stationery, postage and telephone charges.
Fuel and light.

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PROFESSIONAL NOTE.

THE RAYMOND PILE.

(COMMUNICATED BY THE R.E. BOARD.)

A DEMONSTRATION of the driving of one of these piles was recently shown in the neighbourhood of London, and it is thought that the advantages of the system are such as to merit description in the *R.E. Journal.*

The Raymond system of pile driving offers a certain method of producing a concrete pile cast *in situ* without any risk of the concrete being polluted by contact with infiltration from the surrounding soil. This is effected by driving an expanding mandrel covered by a sheet metal shell into the ground. On a suitable depth being reached the mandrel is contracted and withdrawn and the steel shell is left in the ground of the shape of the required pile.

Visual inspection of the shell can be made before pouring the concrete.

The four accompanying plates explain the process of forming and driving the pile. *Plate* I shows the tapered component parts of the pile shell before assembly The sections of the shell are made of 22 to 24 gauge sheet steel reinforced with a helix of $\frac{1}{4}$ in. steel rod spot welded to the shell at the ends. The rod helix itself fits into a shaped helix formed in the shell.

Plate II. gives the view looking down into a driven shell before pouring the concrete.

Plate III. shows the shell assembled on the mandrel and ready for driving.

Plate IV. shows the shell driven and the mandrel in process of withdrawal.

It is stated for this system of piling that, owing to its taper form its holding powers are great; a 20-ft. tapered pile has been found superior to a 35-ft. straight pile. Standard Raymond piles have an 8-in. tip and are at top 16-in., and 23-in. diameter for 20-ft. and 37-ft. 6-in. lengths of pile respectively.

The following points of superiority and advantage over wooden piles are claimed for the Raymond pile in the firm's publications, and can be relied on :—

1. Absolute permanency; not being subject to decay or to the attacks of wood-borers and destroyers—a point which does not admit of argument.

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2. Economy, because of greater carrying capacity—meaning less number of piles for a given load.
3. Smaller and lighter footings, because of decreased number of piles.
4. Decrease in total load to be carried, because of decreased weight of footings.
5. Practical elimination of shoring, underpinning, sheeting, pumping and deep excavation and the reduction of masonry.
6. Important saving of time.

The claim to greater carrying capacity rests upon several points :—

(*a*) Greater size, therefore greater displacement.
(*b*) Greater taper, therefore greater frictional value per square foot.
(*c*) Perfect shape, therefore perfect contact with the ground at every point.
(*d*) Possibility of inspection after driving, hence the ability to load to full capacity, instead of making a large allowance for inefficiency, as in the case of wood piles subject to injury by over-driving, telescoping, departing from the vertical and like defects, none of which are discernible at the moment when correction is possible.
(*e*) Decreased length of pile as a natural consequence of greater size and taper.

In addition, the following important advantage can be guaranteed by the use of this system, *viz.*, increased speed without increase of cost at the present time, as compared to pre-cast concrete piles. Further experience may result in a decrease in cost of the Raymond system. It is claimed that a piled foundation job can be completed in two-thirds of the time as compared with other systems. Twenty-five piles, up to 40 ft. long, can easily be driven with one pile-driver *per diem*.

The above saving of time should result in a considerable general saving of cost over a contract.

The sole licensees of the Raymond Concrete Pile in Great Britain are Messrs. J. & W. Stewart, to whom we are indebted for the loan of the blocks of the plates which accompany this article.

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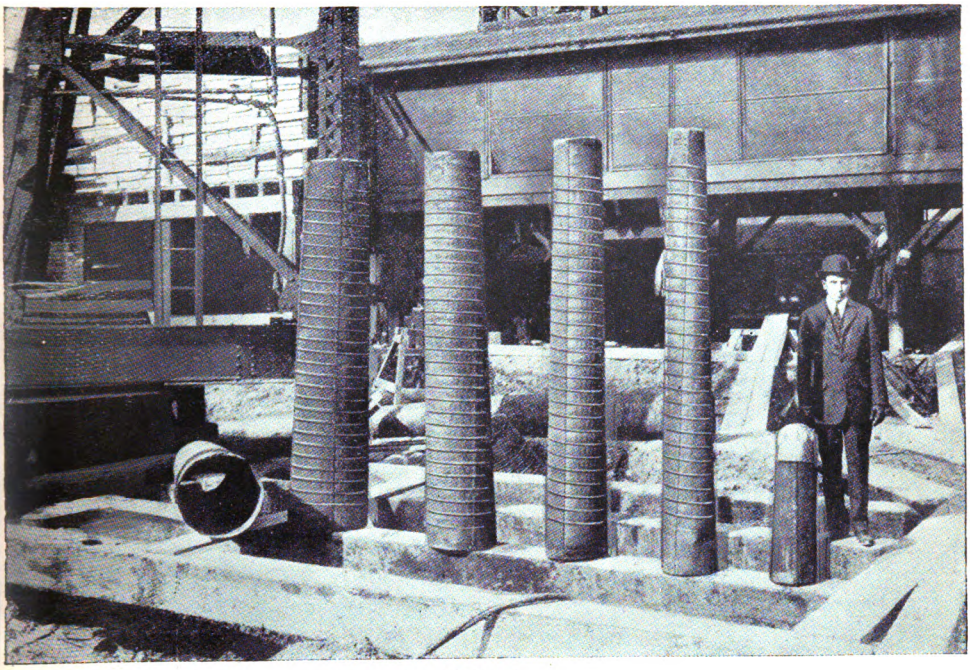

Plate I.

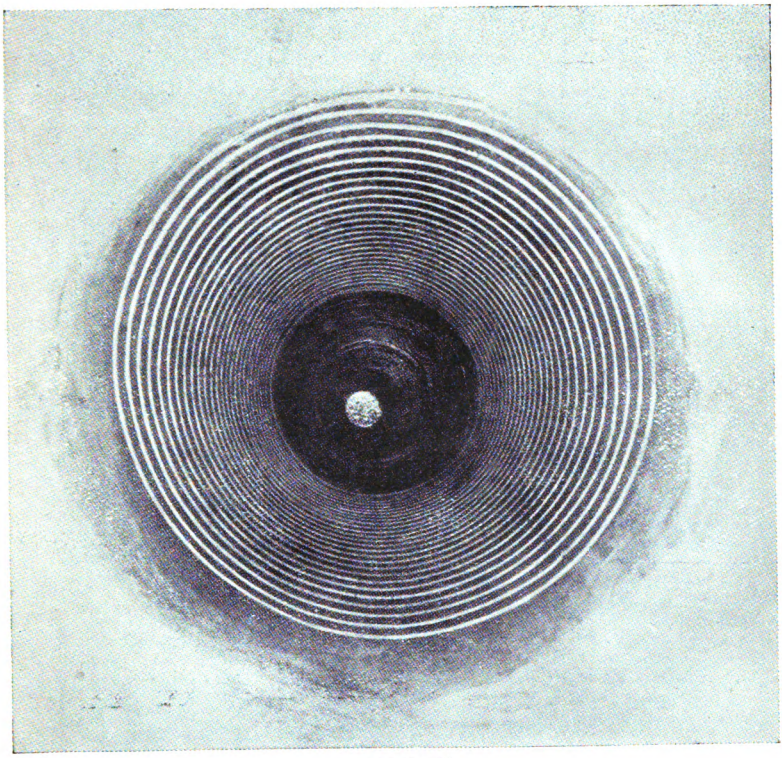

Plate II.

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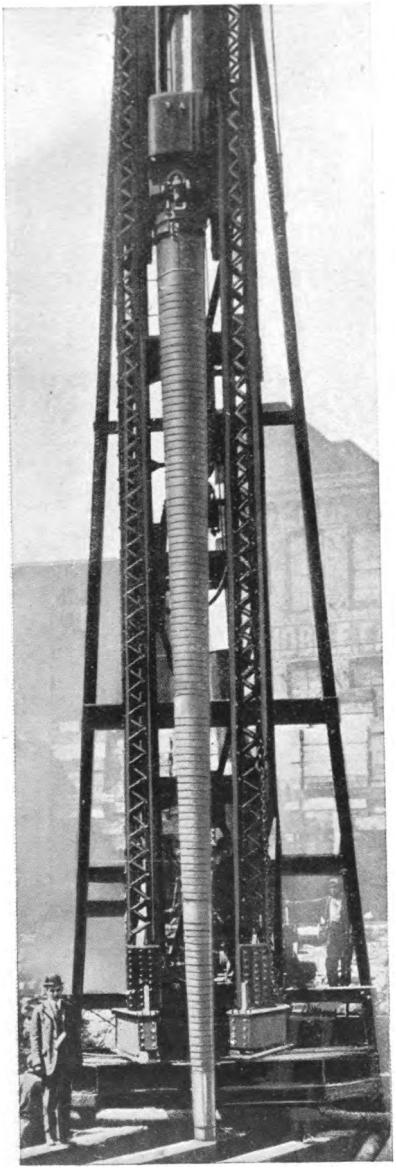

Plate III.

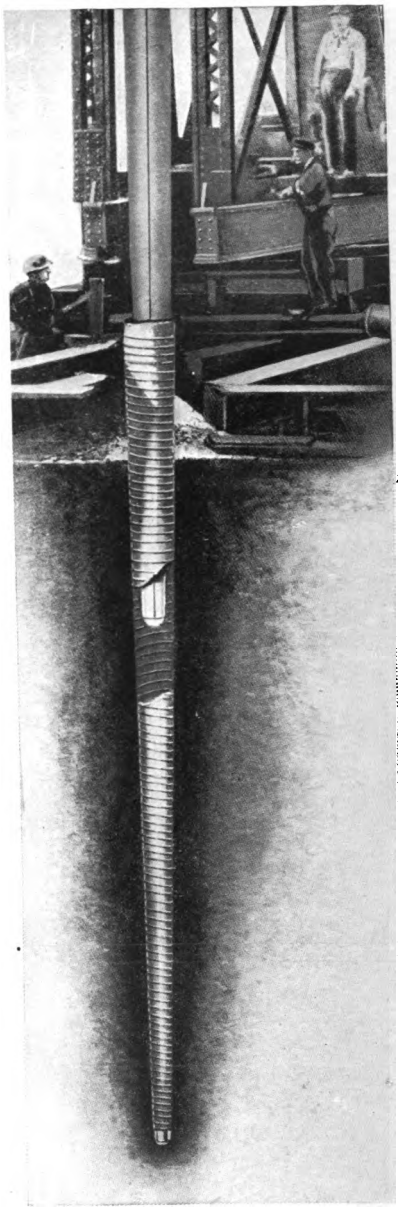

Plate IV.

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*LECTURE NOTES ON THE PRINCIPLES OF THE FIELD SERVICE REGULATIONS.**

By Bt. Lt-Col. L. V. Bond, R.E.

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1. We are constantly told, we constantly tell others, to base instruction on *principles*, to enforce the *principles*, to practise the *principles* of Field Service Regulations.

2. "The fundamental principles of War," say the F.S.R., "are neither numerous nor in themselves very abstruse." Yet we know that the maxims, the rules, call them what you will, laid down in the F.S.R. *are* very numerous, that they are difficult to understand, to learn and to remember. How then can we reconcile the apparent contradiction? What are these few and simple principles of war?

3. Let us begin at the beginning. What is our object in war? To beat the enemy. When is the enemy beaten? Is it only when he is physically or financially incapable of continuing to fight? No. When then is an Army beaten? Prince Kraft has given us the answer in a phrase which Marshal Foch has so convincingly illustrated. "Those troops only are beaten who believe themselves beaten." "A battle lost is a battle one thinks one has lost."

Our whole aim in war is, then, to create on our own side a feeling of confidence, of certainty in success; to create on the side of the enemy, in the heart either of the Commander, of the soldier, of the nation, in any one or in all of these, despair, hopelessness.

"*The secret of victory lies in the hearts of men.*"

4. This is the one, the only, elemental principle of war. All our teaching, all our system, all our regulations are built up on the foundation of this one principle; the one, the only great principle of war, to which all others are secondary, from which all others are derived.

5. At the bottom of all the theory and practice of war is man, the heart of man. On the one side its enthusiasms, its determination, its ideals, its hopes; on the other its weakness, its instincts of self-preservation, its fears, its terrors; above all anxiety, fear, terror in all its manifestations, at its worst panic, that wild unreasoning terror which grips the multitude and sweeps it headlong away.

6. This then is the instrument with which, on which, against which, we have to work. All that we do in peace, our every action in war,

* *Author's Note.*—The following Notes were compiled in September, 1920, before the receipt in India of the new F.S. Regulations, Vol. II. They refer, therefore, to the F.S.R. Part I (1914 reprint) in which the principles of war were not specifically enumerated.

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must be directed towards one object, and one object only; to create on our own side a confidence of winning: to create in the enemy a hopelessness, a despair of winning.

7. We must create on our own side:—

(*a*) In all ranks—(i) Confidence in themselves; due to physical fitness, freshness, the result of youth, physique, physical training; the result in war of good food, good clothing and equipment, good arrangements for billeting, camping, marching, for the advance to the battle; the result of protecting our men from discomfort, and danger.

(ii) Confidence in themselves; due to a consciousness of superiority over the enemy in armament, in training, in skill in the use of weapons, in education, in cunning.

(iii) Confidence in their leaders; due to admiration of their courage, their coolness, their knowledge, the excellence of their arrangements, their care and sympathy.

(iv) Confidence in themselves, their leaders, their comrades, in the army as a whole, due to success in resisting the enemy's attack, but above all to success in attacking the enemy.

(v) Courage; due to all that produces confidence, to national characteristics, to high ideals, to tradition, honour, self-respect.

(vi) Determination to win, determination not to be beaten; due to all that produces courage, to a good cause, *esprit-de-corps*, patriotism, to the team spirit; when all else fails, to that part of discipline which consists of a habit of obedience.

We must create—(*b*) In our subordinate leaders and staffs,

(i) All those qualities enumerated above, and in addition;

(ii) Confidence in those under their command; due to knowledge of their high military qualities, knowledge based on peace training and administration, and on a study of the astonishing tenacity and high spirit of our soldiers as recorded in the history of past wars.

(iii) Confidence in themselves; due to knowledge, above all, of the human heart, of how it reacts to all the influences of war, knowledge based on personal experience of war, on observation of men in peace, on the experience of others in war; that is to say, on a study of the behaviour of troops and of their leaders as recorded in military history, in the records of eye-witnesses of past wars.

(iv) Confidence in themselves; due to a knowledge of their profession, to experience in the handling of troops; to the knowledge that their own dispositions are such that they themselves have nothing to fear from the enemy, that they cannot be surprised, that they will not "let down" others.

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Finally we must create—

(*c*) In the supreme command in addition to *all* the above :—

(i) Confidence ; due to complete knowledge of the enemy, due to the excellence of our intelligence service.

(ii) Confidence in the army, due to a knowledge that it possesses those qualities which we have already enumerated, that it will carry out his wishes exactly, owing to its intelligent discipline, to its excellent organization, to a common system of acting, to a common system of thinking, the result of a common doctrine ingrained in all ranks by a uniform system of training.

Finally :—

(iii) Confidence in the Government and in the nation, that they will not fail in good or evil fortune.

8. We must create on the enemy's side :—

(i) Among all ranks, (*a*) Physical fear ; by killing him, wounding him, destroying him by the use of arms more numerous, more destructive, more skilfully handled, more irresistible than his own.

(*b*) Mental fear ; by continually threatening destruction, by attacking by means which he cannot parry, from directions from which he is unable or unprepared to resist us.

We must endeavour to create, (*c*) The fear of the unseen, the terror of the unknown, by surprise, by acting secretly, swiftly, unexpectedly.

(*d*) Misery, despondency ; due to hunger, thirst, fear, cold, fatigue, lack of sleep, by continually firing at him, threatening him, destroying his communications, his organization, his rearward services.

(*e*) Hopelessness, distrust in his leaders, his comrades and himself as a result of continual reverses, defeats, miscarriages.

We must destroy by propaganda, (*f*) his determination to win, to fight on, by destroying his belief in the justness of his cause, in the good faith of his leaders.

We must create, (ii) In the enemy commander,

(*a*) Crushing anxiety, hopelessness, lack of confidence in himself and in his army, by keeping him in ignorance of our circumstances, of our intentions, by striking suddenly, unexpectedly, overwhelmingly at the point and in the direction which he least expects or wishes, by continual activity spoiling his plans, breaking up his preparations before they have time to mature.

(*b*) A belief in the irresistible superiority of our arms, of our skill, our numbers, our efficiency.

We must create also, (iii) In the enemy nation by victories, by blockade, by propaganda, a feeling of hopelessness, of distrust, a desire to stop the war at all costs.

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9. To strike at the *soul* of the enemy, to establish a *moral* superiority, this must be our one object in war. Our reason affirms it. All history proves it. The records of war teem with examples of armies defeated only by their own terrors, of victory turned to defeat because the heart of the Commander failed him. The history of the British Army is full of instances of victory won against overwhelming superiority of men and material because the British soldier refused to believe himself be:

10. This then is the single foundation from which all other principles are derived,

"The secret of victory lies in the *hearts* of men."

"That army only is beaten which *thinks* itself beaten."

"In war *man* is everything, the rest nothing."

11. Next in importance, yet secondary to this first principle, since derived from it, equally universal in time and place since it is based solely on the unchanging nature of the human soul, secondary, yet itself the basis of all others, comes this principle.

"*Decisive success in war can be gained only by a vigorous offensive.*"

Why is this? Because by adopting a defensive attitude we can, at the best, do no more than convince our enemy that he cannot beat us. It is only by dealing him blows, violent, staggering, repeated blows, blows which he finds he cannot parry, that we can convince him that we are indeed the better men, that he cannot hope to win, that he himself must be beaten. This is true for the individual man, it is therefore true for armies which are but collections of individual men.

12. There is indeed another great principle, elementary in so far as it is derived directly from our first principle, but universal only if we conceive of war in its usual meaning, that is to say, as the struggle of two armed communities each determined to defend itself and, if possible, to defeat its enemy.

The principle is this "*that victory can only be gained by defeating in battle the armed forces of the enemy.*"

The truth of this is evident, since by hypothesis the loser nation starts with hope based on the success of its armed forces; until these are beaten in battle it can still hope for success, it is still unbeaten. But once its armed forces are beaten, unless it can create more or revive their belief in possible victory, it cannot hope to resist longer, it is, in fact, beaten.

This principle, however, is for the use of the supreme Command alone; it is a purely strategical principle.

13. The subordinate leader and the man in the ranks are concerned only with the application against the armed forces of the enemy of the principle of "the vigorous offensive," and from this principle we now find a group of principles derived.

14. First, it is evident that our "vigorous offensive" will have the greatest possible chance of success if we strike the enemy at the most favourable time and place and in the most favourable direction. Which will be the most favourable time, place, and direction? That at and in which a blow will be most irresistible, will most shake our enemy's confidence, disturb his plans, break up his organization.

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To discover which is the most favourable spot, how best to strike, how best to exploit success, we must evidently ascertain as correctly as possible the enemy's strength, his dispositions, his armament, his *morale*, his organization, in fact all about him. We must also know all about the ground and about our own troops, how they are distributed, what is the state of their strength, their *morale*, their armament; we must also know what they are doing. That is the next principle: "*To inform oneself as fully as possible about the enemy, about the ground and about one's own side.*" This involves "intelligence" in all its forms, secret service, maps, air reconnaissance, patrols, observers, raids, even preliminary attacks. As regards our own troops, it involves *liaison*, intercommunication, report centres, contact aeroplanes, reports and returns. It calls for control, strict obedience to orders, movement by bounds and so on.

15. Having decided where to strike and how, we must now prepare the attack. This requires time, it requires space. While we are preparing the enemy may move, may take the initiative, may attack and upset all our preparations. We must prevent this. How? It may be done in various ways. We may prepare the attack out of striking distance and trust to the secrecy and intense speed of our approach to save us from interruption. This method is rarely possible by itself in land warfare. On land, where at present we are still comparatively slow moving, we must watch the enemy so as to divine his intentions, to have timely notice of his moves (protective reconnaissance). We must detail detachments, advance guards, flank guards, rear guards, to stop him, to fix him. We may occupy with these detachments a defensive front; or we may gain time by manœuvre; or we may make a holding or fixing attack. In any case we must invariably take measures to gain sufficient time, and to keep sufficient space for our attacks to develop under favourable conditions. We must take measures of *Security* of *Protection*.

And since in war our information can never be perfect, we must always keep something in hand to counter unexpected action by the enemy, to reinforce a detachment, to re-establish a broken front, to furnish a fresh detachment. We must, in fact, *keep a reserve* (distinct from our striking force), we must *organize in depth*. All these measures are, however, only consequent on the principle itself, which is "*to secure for ourselves freedom of action.*"

16. We have now in all probability used up a large portion of our force in these detachments, defensive fronts, local reserves. If we use too large a portion, the decisive attack, up to which all our preparations are leading, will fail through being too weak. This gives us the principle of "*Economy of force*;" to use as few troops as possible in these subsidiary duties, and with this in view to increase the holding or fixing power of these detachments by making them strong in fire-power in proportion to man-power, by manœuvring as in fighting a rearguard action, by using obstacles, field fortifications. The same principle, Economy of Force, requires us finally so to arrange our detachments that, at the psychological moment, all can join, either directly or indirectly, in the decisive act.

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17. Having secured time and space to prepare, to choose our time and method, nothing in the way of preparation must be left undone which time and circumstances will permit. That is the next principle, "*to prepare for the decisive action as completely as possible*," to foresee requirements and to provide for them.

18. We are now ready for the *dénouement*, the decisive blow, the supreme act of that "dreadful and impassioned drama," war. It must not be allowed to fail, if it is humanly possible to prevent failure. It may still require for its preparation preliminary bombardments, preliminary attacks, subsidiary attacks. But in the end we must put into the decisive battle itself, every man, every gun, every round, every ounce of energy of which we are capable. We must deal a blow or series of blows of the most intense and appalling character possible, with all the resources of the army, of the nation. There must be no half-hearted measures; we must stake everything. This is the principle of unlimited war, "*to strike the decisive blow with all our forces.*"

19. Such then are the basic principles of war, whether in large or small operations :—

1st. *To direct every action against the soul of the enemy*, to make him *think* that he is going to be beaten, while refusing to believe that we are beaten ourselves.

2nd. With this object, *sooner or later, at the most favourable opportunity, to attack, to strike a supreme, a decisive blow.*

3rd. In order that the attack may be put in at the right time and place, *to find out all we can about the enemy, about the ground and about our own side.*

4th. In order that we may prepare the blow, that we may strike how and when we like, "*to secure for ourselves freedom of action*," preventing interference by detachments, by defensive fronts, by secrecy, by speed, by watching the enemy, stopping him, fixing him, mystifying and misleading him.

5th. *To ensure economy of force in subsidiary operations*, by using as few troops as possible, and by so arranging our detachments, keeping touch with them, that at the decisive moment, all can act against the enemy in some way or another, that all can "pull their weight" at the supreme instant.

6th. *To prepare the blow as completely as possible* by a complete organization, by foresight, by mystifying and misleading the enemy, by shaking his *morale*, by secrecy and surprise creating our opportunity.

Finally at the favourable moment

7th. *To strike with all possible violence even to the exhaustion of all our means.*

20. These are the principles of war, and they are of universal application, whether to armies of bowmen and spearmen or to armies of tanks, to fleets of ironclads at sea, or to fleets of aeroplanes.

21. In war, these principles govern our action at all times. Thus, when we are halted, we maintain our intelligence service (reconnaissance). We cover ourselves with outposts and with protective reconnaissance (to secure freedom of action). We keep these outposts as weak as

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possible (economy of force), while we make our main body as comfortable as possible, to keep it fresh, unshaken, fit for the decisive act (preparation, the blow with all our forces).

22. Similarly, during a march, towards or away from the enemy, we cover ourselves with detachments, so that our striking force may march in a sense of security, so that we may have time and space to prepare the blow which we eventually *must* strike, so that we may strike it with full strength, full courage.

23. So also even during the progress of the attack itself we must still learn all we can about the enemy, about the ground and about our own troops and report it (observation, reconnaissance, *liaison*, intercommunication). We must protect ourselves with observers, with detachments detailed for the purpose (such as defensive flanks), by organizing in depth to meet the unexpected. We must also constantly fix the enemy, prevent his counter-action, shake his courage, prepare the way, by covering fire. We must, in fact, continue to ensure for ourselves *freedom of action*. All the time, also, we must remember our fundamental principle. We must look at things from the enemy's point of view, see with his eyes the place at which he most fears attack. This will usually be his flank or rear. Why? Because it is a natural instinct of the human heart to fear the danger that comes from the flank or rear especially when one is already engaged in front, to fear the possibility of being surrounded; and because also, in large forces attack from a flank upsets the enemy's arrangements, causes him anxiety, hunger, possibly even starvation, creating despondency, paralyzing his counter-blow.

If the attack comes unexpectedly, fear is intensely magnified. It may become terror, panic. A unit or Commander surprised is already half-beaten.

So also we shall be attacking where the enemy least wishes, if we press our attack at his weak points and waste no force on the strong points. What are his weak points? Those at which we have already penetrated. This is what we call "Soft spot tactics," a most elementary application of the first principle of war.

Finally, we must push the attack *with all our forces*. This implies fresh troops, kept in hand. It implies organization in depth; first, to encourage those who go ahead, since the human heart fails if, seeing terrors ahead, it sees not also help coming from behind; and second, in order that we may put in *fresh* and yet more *fresh* troops as the leading lines lose their vitality: fresh troops whom we have brought up with all possible care, in good order, under cover, as fresh, as unshaken as possible, so that they may apply the maximum of force, so that they may enter the battle with a maximum of confidence, of courage.

24. But if the enemy seizes the initiative, if he attacks us, do we then still act on the same principles? Most certainly. We still reconnoitre. We still hold him with detachments, with our fighting front which we keep as weak in troops as possible, increasing its resisting power with guns, machine guns, obstacles, field fortifications, using only such reserves as are necessary to close gaps, to make local counter attacks; employing always as few men as possible (economy of force). We secure in this way time and space (freedom of action) to collect, to keep

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fresh the main body, the striking force, to prepare in security the decisive counter-blow which must be made.

25. Let us open the Field Service Regulations at random. We shall find no sentence, no rule of action which does not react to one of these principles.

These then are the fundamental principles of war. They are "neither numerous nor in themselves very abstruse."

26. "But the application of them is difficult and they cannot be made the subject of rules."

Why is the application of them difficult and why cannot they be made the subject of rules? Because the human heart itself is complex; because the circumstances of war, the position of the opposing forces, their characteristics, their armament, their strength, the incidents of the ground, the weather, all these vary to an infinite degree. No two cases in war are ever exactly alike. *Every case in war is a special case* which must be treated on its merits.

27. What then are these two hundred and more pages of reading matter in the Field Service Regulations? They do not all contain fundamental principles of war. The fundamental principles of war could be printed on a single page. They cannot contain rules of war, since there can be no rules. How then can we explain them?

In this way. If we are to act on the orders which we receive exactly in the way in which our Commander desires us to act, if the Commander is to be in a position to lay his plans with accuracy and precision, if we are to act in harmony with those around us, if we are to rely on them and they on us, we must have, not only a fixed organization for the whole army, but we must also have a common method, a common system of acting, a common phraseology; so that whoever gives us an order may do so with a general knowledge of how it will be carried out: so that whoever receives an order may understand clearly what is intended.

The Field Service Regulations and our Training Manuals provide us with such a common method of acting in the face of a large variety of circumstances such as may occur in a war against an enemy armed more or less with a certain type of weapon, of a certain degree of organization, in a certain type of country—a method which has been "evolved by experience as generally applicable to the leading of troops" and departure from which "has often been followed by mishap." If circumstances are very different we must, of course, largely revise our method. The modifications generally necessary to meet the case of warfare against uncivilized enemies in certain types of country are indeed provided in the Field Service Regulations. But though the method provided in the text books may more or less meet a given case, it can never exactly do so. The method is very elastic, it admits of modifications and it must be modified in *every* case, since *every* case is a *special case.* We can never therefore act entirely from memory, even if memory did not desert us in the stress of the war, nor yet from habit in solving any but the most simple or invariable of problems. We must in every case *think.* We must consider how the common method fits the special circumstances and modify the method on the basis of the fundamental principles of war.

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28. It is evident then that we must have, in addition to a common method of acting, a common method of thinking, of appreciating a problem ; so that all, being faced with the same problem, would act more or less in the same way. Where is this method of thinking laid down ? Nowhere in our regulations. We must therefore evolve a method, or, better still, adopt a method which has achieved success. Let us then follow the teachings of Marshal Foch.

29. Let us first realize that, with the exception, perhaps, of the supreme commander every one of us is acting under orders. We have each a task to perform, one definite task and no other. We must therefore be absolutely clear first of all as to what that task is. What is it that we have to do ? We must, in fact, answer the question which Marshal Foch has made so familiar to us : " What is the problem ? " Having decided this, we may then test our problem with the " principles of war " in the order in which we have enunciated them.

Thus " What do I know of the enemy, of the ground and of our troops ? Do I know sufficient to make a plan with certainty ? " We can never, of course, know as much as we should like to know, since the enemy also is acting, is always changing his position, etc. We must therefore always arrange to reconnoitre and observe.

We must then ask ourselves : " What is my general plan ? " We may decide to march to a certain place by a certain road, to attack more or less in a certain direction, to resist on a certain line. Then, " What must I do to guard against the enemy's counter-measures, that is, to secure for myself freedom of action ? " We cannot answer this question without looking at the situation from the enemy's point of view. We must see with his eyes, feel with his heart. This is a most valuable practice, a practice too little followed.

Then, " What is the least force that I can use for the purpose of securing freedom of action ? " " How can I arrange so that my detachments may remain under my control ? "

In a march, a retirement, a defence, a full answer of the above questions may be all that is necessary for the formation of a plan to carry out our responsibilities.

If, however, our portion of the general task involves attack of any kind we must think also " How must I organize and prepare the attack so that the blow may be as strong, as violent, as unexpected, as terrifying as possible, so that I may be able to employ *all* my forces, if necessary ? "

30. We cannot expect, of course, always to have time to review the situation in detail. When in close contact with the enemy a new situation will present itself for solution every moment. In such circumstances practice in the common method of action will save us, for we shall decide subconsciously, as by habit, to act in a manner more or less correct ; and a mind well practised in the common method of thinking will then suggest to us, at times almost instantaneously, the modifications necessary to meet the special case. In the same manner, on the football field, although every moment presents a different problem for the solution of which there can be no exact rule, yet we keep a certain general formation and act subconsciously on a certain common method while solving consciously, though more or less instantaneously such

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highly complicated problems as when and where to pass, how to swerve, and when to shoot.

31. But it is not sufficient for the commander to make a correct plan. The plan must be carried out, and correctly carried out. To achieve this we must issue orders, and our orders must be so concise, so clear, so simple, that there can be no mistake either in understanding or in executing them. Every subordinate must be given a definite task and a perfectly clear idea of his task, so that he can unhesitatingly answer, as regards himself, the question "What is the problem?" We must also give all the information required for solving that problem and carrying it out; that is to say,

(*a*) news of the enemy; (*b*) news of our own troops; (*c*) the intention of the commander; (*d*) the particular orders for each sub-unit of the command; (*e*) the arrangements for control (report centre).

In order that we may forget none of these, our orders, whether written or verbal, should always take this form and sequence. Field Service Regulations again supply us with a common method.

32. Let us remember, however, that in the rapidly changing situations of war orders can only hold good for a certain time. We must therefore so arrange matters that we can modify our orders, or issue fresh orders when necessary. This implies *liaison*, intercommunication, extension postponed till the last moment, close and handy formations, limited objectives, movement by bounds.

33. Our action must follow this order:—(*a*) clear, correct thinking; (*b*) clear, simple orders; (*c*) control retained to the last possible moment.

34. Finally, let us remember again in all we do, in all we think, that one fundamental all-embracing principle that "That nation, that commander, that army is only beaten which thinks itself beaten." Let us keep in mind the knowledge that victory depends on skill, numbers, armaments only in so far as these tend ultimately to raise the confidence of our own side, to create despair in the hearts of the enemy.

There is nothing else in war but this: to frighten the enemy into thinking that he is beaten, to resolutely cast out fear from our own hearts and to refuse to be beaten.

To arrange *everything* with a view to causing the enemy the maximum of discouragement, of fear; while so acting as to create on our own side the maximum of energy, of confidence, of courage. How essential to the leader then, above all things, is a knowledge and understanding of the human heart. "The secret of victory lies in the *hearts* of men."

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Colonel R. A. Wauhope, C.B., C.M.G., C.I.E.

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MEMOIR.

COLONEL ROBERT ALEXANDER WAUHOPE, C.B., C.M.G., C.I.E.

(*With Map.*)

By COLONEL SIR S. G. BURRARD, K.C.S.I., F.R.S.

THE late Colonel Wauhope won a high reputation in India as an explorer and surveyor of the mountainous trans-frontier regions. Having accompanied many expeditions against warlike races and tribes, he had become a past-master of the art of surveying, as it has to be practised in the midst of an armed and hostile population. A born geographer and linguist, a strong and keen mountaineer, he seemed to have been specially designed for the arduous tasks that were allotted to him through life.

The advance of Russia across Central Asia in the seventies and the Afghan war of 1879 had brought home to the Indian Government that their trans-border areas were not only unmapped but unexplored; after fighting two Afghan campaigns, 1839 and 1879, the army of India was still without a map of the borderland. Wauhope's career opened at a time when the authorities had become impressed with the necessity of building up surveys of that wild frontier zone, concerning which little was known beyond the fact that any attempt at exploration would be forcibly resisted.

Colonel Wauhope was born at Monkstown, Co. Dublin, in 1855, and was the eldest son of Colonel Henry John Wahab, 48th (Northamptonshire) Regiment. His original surname was Wahab, but in middle life he reverted to the older spelling of Wauhope, in accordance with a family agreement. He was educated at Durham School, 1866–1871, and at the Royal Military Academy, and he passed into the Royal Engineers in 1873. He carried away from school not only a solid groundwork of mathematics that enabled him to deal easily with the formulæ of geodesy and astronomy, but also a rare knowledge of the classics, which was a constant help in his studies of the oriental languages.

In 1875 he joined the Madras Sappers and Miners, and two years later he served with the expedition that was sent to suppress the Rumpa rebellion. In 1878 war was declared with Afghanistan, and Wauhope served with the Peshawar Valley field force as an assistant

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field engineer, until the peace of Gandamak was signed in 1879. Under this treaty a British Resident proceeded to Kabul and was honourably received by the Amir, but six weeks later he and his staff were murdered, and a British Indian army again invaded Afghanistan. In this second campaign Wauhope served with the force that advanced on Kabul under General Roberts. Peace with Afghanistan was finally declared in 1880. In 1881 Wauhope served with a military expedition against the Mahsud-Waziris.

It was on these campaigns that he first came into contact with the hardy Mahommedan races whom he subsequently knew so well, and it was on these campaigns that he first witnessed the difficulties of surveying under the eyes of a guerilla enemy.

After serving for 18 months in the Military Works Service at Lahore and Meerut, he was appointed to the Survey of India in 1883, and was posted for training to Major Charles Strahan's topographical party in Rajputana.

Western Baluchistan.—Under the treaty of 1880 the Amir of Afghanistan had recognized the suzerainty of the Indian Government over Baluchistan. Sir Robert Sandeman had been the chief political officer in Baluchistan during the Afghan wars, 1878–1880, and on the conclusion of peace he was appointed the first Agent to the Governor-General for Baluchistan. In 1883 Sandeman decided to undertake a mission through West and South Baluchistan for the purposes of exploring the country and of initiating friendly relations with the chiefs. A survey party, under Lieut. the Hon. M. G. Talbot, R.E., was attached to the mission, and Wauhope was selected to be Talbot's assistant.

The vast extent of territory which had lately come under British rule between India and Persia was largely a *terra incognita ;* on the best maps then available thousands of square miles were shown as sandy desert, which were afterwards found to be covered with ranges of mountains rising to altitudes of 10,000 feet

On October 5th Talbot assembled his party at Jacobabad, where Wauhope and the two surveyors Ikbaludin and Ata Mahomed joined him. The party met Sir Robert Sandeman at Quetta, and arrived at Kalat on October 30th. Wauhope and the two surveyors and half the Khalassies were now suffering from fever, and Wauhope recorded in his diary that everything was looking bad for the success of their expedition, except that " Talbot kept well, and did everything." After a week's halt the epidemic had abated, and the party were able to move forward. Talbot and Wauhope worked independently of one another towards Persia, the former exploring the southern country, and the latter the northern. They both had to cross mountain ranges and their plan was to effect a junction at Kharan, a Baluchi town, where Sandeman had directed them to meet him. On December 23rd the survey party met the political

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officers at Kharan, and on Christmas Day, Sir Robert entertained all the members of the mission at a dinner in his tent. After Kharan, Talbot and Wauhope worked together, Talbot taking the triangulation and Wauhope the topographical detail, and jointly they carried the survey over the hills of Western Baluchistan. In January they met Sandeman again at Panjgur, and received directions from him to explore westwards to the Persian boundary, but to avoid entering Persia. Through February and March the operations progressed successfully, but in April observations became difficult. Wauhope recorded in his diary—"This haze is now becoming a constant annoyance, stopping all distant sketching entirely; a month ago when we had clear weather every detail twenty miles away was visible; now we can just see hill tops looming through the mist and nothing in the valleys."

On April 23rd the mission returned to Quetta, and Sir Robert Sandeman, in bidding farewell to the members, expressed himself very pleased with the political and geographical results obtained.

On May 22nd, 1884, Capt. Wauhope was married at Meerut to Miss Catherine Ward, the elder daughter of Colonel David Ward, R.E.

The Zhob Valley.—In 1884 Sir R. Sandeman obtained permission to explore the Zhob Valley and to take with him a field force with which to punish the Kakar Pathans for their raids. Major Holdich was appointed to the charge of the Zhob survey party and Wauhope was nominated his assistant. It was just at this time that the Russian army, having conquered the Turcoman states, advanced to the northern boundary of Afghanistan and came into collision with the troops of the Amir. Great Britain had guaranteed the integrity of the Amir's dominions and an acute crisis ensued; eventually Russia agreed to recognize the independence of Afghanistan, and to co-operate with Great Britain in demarcating the northern Afghan boundary. Major Holdich was now selected to be Chief Survey Officer with the Afghan Boundary Commission and an unexpected vacancy thus occurred in the Zhob Valley survey party. There were senior officers who had claims for the Zhob appointment, but they were at distant stations; the matter was urgent, Sandeman wanted Wauhope and Wauhope, being on the spot, stepped into the vacant charge.

The Zhob valley lies between Baluchistan and the Punjab frontier; it separates the Quetta plateau from the Sulaiman range, and it stretches northwards to the Gumal river of Waziristan. In neither of the Afghan Wars, 1839 and 1879, had this tract been traversed by British troops, and before the Zhob expedition of 1884 it was geographically unknown. The best map available in 1884 showed the Zhob river cutting across the Sulaiman range into the Punjab, 80 miles south of the Takht-i-Sulaiman Peak, whereas Wauhope

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discovered that the Zhob flowed northwards into the Gumal and escaped from the mountains 30 miles north of the Takht-i-Sulaiman.

Sir R. Sandeman and the field force, under Sir Oriel Tanner, reached Smalan on October 1st, and there the survey party joined them. Wauhope's assistants were Mr. G. B. Scott and Surveyor Yusuf Sharif. On October 20th Wauhope first entered the Zhob Valley, which he described as "a broad alluvial plain, 10 miles across, bordered by mountains, and stretching away as far as the eye can see." As the expedition progressed he carried on a triangulation from the summits of hills, and by computing his results daily he was able to supply the plane-tablers with the positions of the new points, almost as soon as he had fixed them. On October 22nd a survey detachment came under fire from the Zhobis and four of the escort were killed. On the 24th the Zhob chieftain Shah Jahan made a determined attempt to stop the expedition from advancing, but his men were defeated with heavy loss. Two days later the force reached Shah Jahan's fort only to find it abandoned; the towers were then blown up, the Zhobis watching the demolition from their hills. Sandeman was anxious to get maps made of the lateral valleys, and General Tanner arranged for military escorts to accompany the several exploring detachments. The expedition returned to Quetta in the spring; there was some disappointment that Shah Jahan's opposition to the force had proved so feeble, but the results achieved by the expedition were of lasting value; Sandeman's influence began now to spread from Baluchistan over the Kakar Pathans, and a large blank in the maps of the frontier was filled in.

On his return from Zhob, Wauhope remained in Baluchistan, carrying out surveys of various areas. It was at this time that he designed his "Height Indicator." The introduction of the clinometer in 1876 had enabled plane-tablers to insert contours on their maps, but even with the clinometer a surveyor had to calculate each observation before he could ascertain the height of a surrounding point. In Baluchistan, Wauhope introduced a graphic method by which heights could be read off from a diagram, and he thus relieved his surveyors of the calculations. His Height Indicator has proved an important contribution to surveying, and it is now recognized as an essential article in the equipment of a topographical surveyor.

Campaigns on the Punjab Frontier.—A belt of independent tribal country runs along the Indo-Afghan frontier from the Zhob valley to the Khaibar pass, but beyond the Khaibar it leaves the actual frontier and bends inwards to Buner and Hazara. The river Indus in its submontane course cuts across the eastern end of this tribal belt, and it is for this reason that a considerable length of the great Punjab river has never been systematically explored. There has been a clash of races on the Indus, a clash of the Tibetan and Afghan and Hindu; on its long high-level course above 4,000 feet the Indus

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flows through a peaceable country, where Mongolian blood predominates, and where geographical exploration has been unopposed; but, in its middle course, during its descent from the plateau to the plains, the river passes through lawless tracts where surveys have only been possible on campaigns. In these surveys Wauhope has played a leading part.

In 1888 he accompanied an expedition for exploring Southern Waziristan. Later in the same year he went in charge of the survey party on the Black Mountain campaign, and made useful maps of the hills on the east bank of the Indus. The General Officer commanding reported in his dispatches that Wauhope was unremitting in his endeavours to seize every opportunity during the march of the field force to secure extension of his surveys, and that he deserved much credit for the thorough manner in which the new country had been mapped.

In 1889 he went to Chatham to undergo various courses of training, and he returned to India in 1890. Early in 1891 he was selected to accompany the Miranzai field force, which operated from Kohat against the tribes occupying the outer hills between the Kurram and Khaibar passes. In the summer of 1891 he served as survey officer with the Hazara field force, when he was able to extend the surveys which he had made on the Indus during the Black Mountain expedition of 1888. The annual report of the Surveyor General for 1891 refers to the topographical results of these expeditions as being most creditable to Capt. Wauhope and acknowledges the excellent services which he had rendered on many frontier campaigns and which had so often been brought to notice in Army dispatches.

In 1891 the authorities at Aden were meeting with difficulties in settling the disputes amongst various tribes of South West Arabia which had come under British influence during the preceding half century. In October, 1891, Wauhope took a party to Aden with orders to survey the hinterland. Maps of the country round Aden for a distance inland of 70 miles were completed by the following May, when the work was stopped by the heat and the party returned to India.

In 1892 Wauhope was Survey Officer with the Isazai field force, which was operating against the tribes in Buner on the west bank of the Indus.

The Durand Boundary.—In 1893 a mission under Sir Mortimer Durand proceeded to Kabul and was received by the Amir Abdur Rahman. The negotiations were successful and an agreement was signed by which the boundary between India and Afghanistan was to be settled and demarcated. This agreement was remarkable, not only for the way in which the Amir had been induced to withdraw his known objections, but also for the boldness of the scheme under which lines of pillars were to be erected across the frontier

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mountains which had for centuries been the homes of India's marauding enemies.

Landi Kotal, at the head of the Khaibar Pass, was one of the pivots of the Durand line, and in 1894 a commission, consisting of Mr. Udny and Mr. Hastings, political officers, and of Colonel Holdich and Lieut. Coldstream, Survey Officers, set out from Peshawar to mark the Indo-Afghan boundary from Landi Kotal northwards to the Hindu Kush range*. To the immediate west of Landi Kotal no demarcation was necessary, as the Durand line followed the crest of the Safed Koh range. But beyond the Kurram came the Waziristan section, and Wauhope was selected as Chief Survey Officer for Waziristan. West of Waziristan was the Balchistan section ending at the Persian border; Capt. MacMahon was the political officer for this last section, and Capt. Mackenzie and Mr. G. P. Tate were the Survey Officers.

The central pivot of the Durand Boundary was to be a pillar erected near Domandi on the river Gumal in Southern Waziristan. Domandi was to be the junction-point of the frontier lines of India and Baluchistan. Wauhope's duties were to survey the Durand line through the Waziri hinterland and to assist the political officer in demarcating it from Domandi to the Kurram.

The Amir had subjugated the tribesmen on his side of the boundary, but on our side the Mahsuds and Waziris were independent, and it was expected that they would endeavour to stop the demarcation by force of arms. The political officer who was deputed to treat with the Amir's representative was Mr. L. W. King, I.C.S.

Wauhope assembled his party at Dera Ismail Khan on September 30th; it consisted of Capt. C. L. Robertson, R.E., and Surveyors Abdul Ghafur, Husen Baksh, Sher Jung, and Jafir Ali; a few days later it was joined by Capt. P. F. J. Macaulay, R.E., who had been fixing boundary pillars in the Kurram. The survey party marching by the Gumal Pass, reached Karkana Kotal on Oct. 14th, and here they commenced their work. It was essential to carry the surveys across Waziristan to the Afghan border, so that the maps of the Durand line should be connected with those of India. On October 19th a brigade of troops marched through the Gumal Pass, and on the 25th reached the plain of Wana. Robertson and Macaulay carried out surveys on both flanks during the march to Wana. The Waziris were firing into the encampments at night and the Mullah Powandah was in their midst preaching the duty of war. On November 3rd a strong force of Waziris made a night attack upon the camp at Wana, and, having overpowered the outposts, a large body broke into the camp. They succeeded in cutting horses loose

* *The Indian Borderland*, by Sir Thomas Holdich, 1901.

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and in causing a certain amount of confusion in the dark, but they were soon driven out by the Indian troops.

Our casualties were heavy, and when daylight came, Capt. Macaulay, R.E., was found to have been killed.

It was not till two months after the fight at Wana that King and Wauhope reached Domandi, a small village on the Gumal. In agreement with Abdul Wahid, the Afghan representative, King selected the site for the Domandi mark-stone ; Wauhope erected the cairn, and determined its latitude and longitude ; Husen Baksh sketched the topography of the surrounding country. King and Wauhope then marched across the hinterland, erecting cairns along the boundary. The villagers showed disapproval of the proceedings of the commission, and the political officer was anxious to push on rapidly before the local dissatisfaction could come to a head. But the work of deciding upon the actual boundary line occupied less time than the surveying and hill-sketching, and Wauhope found it impossible to hasten his triangulation and mapping. Snow-storms were of frequent occurrence, and the survey work, being more dependent upon visibility than the demarcation, was retarded. Every day when the sites of the pillars had been settled the surveyors had to climb many thousands of feet in the snow in order to make the necessary observations.

At the last pillar of Southern Waziristan, Wauhope received orders not to cross the watershed between the Gumal and Tochi, but to return to the Punjab by the Gumal route and to make a fresh start up the Tochi into Northern Waziristan. The British and Afghan missions therefore parted company, and Wauhope marched back to Wana and down the Gumal Pass to Bannu.

Robertson and Sher Jung who had been surveying Southern Waziristan also joined at Bannu. Mr. H. A. Anderson, Commissioner of the Derajat, was appointed political officer for the demarcation across the valley of the Tochi. The new mission marched up the Tochi under the protection of General Egerton's brigade, and on March 3rd they arrived at Sheranni*. Here they were met by the Amir's officer Abdul Wahid. On March 6th Anderson and Wauhope, with a small escort, marched 30 miles south of the Tochi to the spot where the Gumal line of pillars had ended, and they erected the first Tochi cairn on the hill of Kharkamar. In the evening some shots were fired into their camp, but these proved to be accidental and merely due to a fight in the camp of the Afghan mission amongst themselves ; the Amir's representative sent his excuses. The two missions spent the whole of the next day out on the mountains, and

* An instructive description of the Tochi was published in the *R.E. Journal*, October, 1921, entitled " A Frontier Motor Road," by Major A. H. Bell.

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long discussions over the boundary took place. It was a wild country and the people appeared even less civilized than those of the outer hills. As the missions passed the small village of Atsar, Wauhope heard an uncouth Waziri shout out to the guides, "Are we to be English (Angrez) or Afghan?" and he gesticulated with pleasure when the guide shouted back—"You are to be English."

Heavy rain and mists often obliged Wauhope to sit on the hill-side for hours unable to observe; the political officer was averse to halting inside Afghan territory, and the rations of the mission were running short. On March 11th the party descended into the bed of the Tochi, five miles above Sheranni, where they were met by General Egerton and his brigade, and where they were able to replenish their rations—now completely exhausted. On March 12th they ascended the hills on the north side of the Tochi, but failed to come to any agreement with the Afghans. On March 13th they proceeded up the bed of the Tochi, taking 10 days' rations; heavy snow-storms occurred and snow lay deep upon the hills, but they were able to fix two pillars near the head waters of a feeder of the Tochi.

On April 4th Anderson and Wauhope reached the peak of Laram, near the Kurram, and here they erected the last cairn of the Waziristan section of the Durand boundary. Whilst Wauhope had been mapping the belt of country through which the line passed, Robertson had been surveying the area round Sheranni, and between them they had produced a valuable map of Northern Waziristan.

The Russian Boundary across the Pamir Plateau.—Mr. Udny and Colonel Holdich had meanwhile extended the Chitral section of the Durand line to the snow-capped crest of the Hindu Kush. Immediately north of the Hindu Kush a thin strip of country (Wakhan) had been allotted to Afghanistan; it is from 10 to 20 miles wide and it stretches across the Pamir Plateau for over 200 miles, as far as the Chinese frontier. This narrow Afghan buffer, separating India from Russia, has a natural boundary on its south side in the Hindu Kush range, but on the north the Russo-Afghan boundary required to be settled. The Pamir Boundary Commission was therefore formed in 1895 under General Gerard with Colonel Holdich as Chief Survey Officer*. Having recently finished his work in Waziristan, Wauhope was appointed to the new Pamir Commission, and Surveyors Abdul Ghafur, Asmatullah Khan, and Dan Singh were also selected for it. Marching through Kashmir and Gilgit and *via* the Darkot Pass (15,000 feet), the Commission met the Russians near Lake Victoria (13,400 feet) on July 28th. A pillar near the lake was the principal station of the boundary; triangulation was carried across the plateau, and maps of the country were made by the

* *The Indian Borderland*, by Sir T. Holdich.

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British and Indian surveyors, and printed off from a field press for the use of the commissioners. The selection of the boundary line gave rise to no serious disputes and the settlement was completed in September. On September 15th, from the summit of Andamin Peak (17,273 feet), Wauhope was able to see the Pamir peak of Mustagh Ata (height exceeding 24,000 feet). It was 60 miles distant to the north, and, unfortunately, it was too faint for accurate observation. This remarkable peak is situated outside the range of the Indian triangulation, and neither its position nor its height are accurately known; an observation by Wauhope from Andamin would have been of great geographical interest, but the haze was so dense that he was unable to get an intersection.

Between 1860 and 1880 some snow peaks of the high Hindu Kush range had been observed from the south from the Gilgit stations of the Indian Survey, and their positions had been fixed. The Pamir surveys of 1895 were north of the Hindu Kush, and Holdich and Wauhope saw these peaks standing on their southern horizon at a distance of 50 miles. By careful observations of the peaks, they were able to connect their Pamir triangulation with the triangulation of India. The method they adopted is known to surveyors as the method of resection; the positions of the peaks were first fixed from the south, and then the surveys on the north side were based upon the peaks. In this way a geographical connection was made between the survey of India and that of Russia in Asia.

Seventeen years later, in 1912–13, Capts. H. G. Bell and K. Mason, of the Royal Engineers, made a geodetic connection between the triangulations of India and Russia: the Hunza river has cut a deep gorge across the Hindu Kush range, and Bell and Mason succeeded in observing a continuous series of triangles through the gorge. The station of Kizil-Rabat on the Pamir plateau, which had been fixed by Holdich and Wauhope in 1895 was independently fixed again by Bell and Mason in 1913. The results obtained were as follows:—

GEOGRAPHICAL POSITION OF THE KIZIL-RABAT MARK.

Date.	Observers.	Resulting Latitude.	Longitude.
1895	Holdich and Wauhope	37° 27′ 27″	74° 44′ 36″
1913	Bell and Mason	37° 27′ 23″	74° 44′ 35″
	Discrepancies ...	4″	1″

The smallness of the discrepancies shows that the Pamir triangulation of 1895 amply fulfilled the requirements of the boundary. The Holdich-Wauhope connection was carried out under service

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conditions, the time allowed for it was limited, the snow-peaks, which formed points in their triangulation, could not be visited, and the angles at them could not be observed.

The Bell-Mason connection was carried out under scientific conditions, with a superior instrumental equipment, and with no time limit; all its triangulation points were visited and all its angles observed.

The connection of 1913 placed Kizil Rabat 135 yards S.S.W. of the position assigned to it in 1895. On a map of Asia, on the scale of 1,000,000 an error of 135 yards is unplottable, being less than the two-hundredth part of an inch, and is therefore not geographically important. But the scientific precautions taken by Bell and Mason have been justified, for an error of four seconds in latitude is sufficiently large to vitiate an investigation either of the Earth's axes or of the attraction of the Pamir mass.

Sir Thomas Holdich has recorded that—"the success of the Pamir Triangulation of 1895 was due to Wauhope's capacity for climbing great heights rapidly, and to the promptness with which he observed rounds of angles from the summits. No one but a highly experienced surveyor could have made this connection between the triangulations of India and Russia."

The Persian-Baluch Boundary.—In 1895 the Government of India made an agreement with the Shah of Persia to settle the boundary between Persia and Baluchistan, the extreme western boundary of the Indian Empire. A special commission was appointed, Colonel Holdich being selected as Chief Commissioner, and Colonel Wauhope as Survey Officer*. The commission reached the Persian boundary on February 20th, and there met the Persian commissioners. The boundary-line had to be selected and surveyed from the shore of the Arabian Sea to the peak of Koh-i-Malik Siah, the south-west point of Afghanistan.† Over the greater part of the distance the boundary followed the crests of barren ranges, where there were no serious obstacles to a settlement; a considerable difficulty, however, arose at the great lake of Mashkel. Here the commission found abundant water, and it was necessary to survey in detail the lake and its groves of dates. These dates had been the cause of serious disputes between Baluchis and Persians, probably for centuries.

The headquarters of both commissions were encamped by the

* *The Indian Borderland*, by Sir T. Holdich.

† This mountain, the trijunction point of the three countries, Afghanistan, Persia, Baluchistan, was first observed with a theodolite in 1884, when Wauhope intersected it. Its geographical position was first fixed in 1896 by G. P. Tate, Survey Officer with the Durand boundary commission. It was made a principal station of the Great Trigonometrical Survey of India by C. M. Browne, R.E., in 1908.

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THE INDO-AFGHAN FRONTIER.

Scale: 94·6 miles = 1 inch

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lake for some weeks. By the end of March the boundary had been demarcated for 300 miles, and the final agreement and maps were signed. The British commission then marched back across Baluchistan to Quetta, where they arrived in May, 1896.

Colonel Wauhope was travelling home by train from Quetta to Simla, when a tragic calamity occurred. His wife with their two children had been staying at a bungalow in the hills a few marches out of Simla, and she was riding back to Simla to meet her husband on his return from Persia. Her horse took fright at a monkey near the road and leapt over the cliff in the presence of her children. She fell thirty feet and was severely injured. She died at Simla a week later. Wauhope took his children to England, and he did not return to India till October, 1897.

The Campaign in Tirah.—As his steamer dropped anchor at Bombay, he received news of the campaign in Tirah, and of the fighting at Dargai, where several of his oldest frontier friends lost their lives. On landing in Bombay he found orders awaiting him to join the army in Tirah, and he left the same day by the Punjab train.

The Tirah campaign was directed against the Afridi and the Orakzai tribes; the army employed was the largest force that had been organized for frontier tribal warfare. It was commanded by Sir William Lockhart, afterwards Commander-in-Chief in India, and the Chief of the Staff was General Nicholson, afterwards Field-Marshal Lord Nicholson. The force marched through the Tirah country, and fought a guerilla war against the tribes. Colonel Holdich was the chief survey officer, and Wauhope became his senior assistant. In February, 1898, before the campaign was over, Colonel Holdich had to retire under the age rule, and he handed over the charge of the several Tirah surveys to Colonel Wauhope in the field. Wauhope served as Chief Survey Officer with the Tirah field force up to the end of the campaign, and he supervised the drawing of the new maps during the following summer. During this campaign surveys were made of valleys and hills in the Afridi and Orakzai countries, which had hitherto been blanks upon the maps.

During the years 1899 and 1900 Wauhope remained in charge of the frontier party, and carried out surveys on both banks of the Indus in the hills above Buner and Hazara.

The Anglo-Turkish Boundary in S. W. Arabia.—The years 1885 to 1896 were remarkable for the number of boundary settlements that were undertaken in Asia; during that period long lines of cairns were erected across mountains and valleys and deserts, which only a few years before had been unexplored. Afghanistan, always hostile to surveys and settlements, was now hedged round with markstones; the Russian advance from the north had been stopped by a line of pillars; there were pillars across the Pamirs, pillars

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through the Waziri hinterland, and pillars round Baluchistan. It seemed as if the boundary problems had been solved and that the era of demarcation had come to an end.

But in 1901 the question of the Anglo-Turkish boundary in South West Arabia was forced upon the attention of the Indian Government by disputes amongst the various Arab tribes. In 1839 Great Britain had taken over the port of Aden with the consent of Turkey, and in the next half-century several tribes of the hinterland had come into direct relationship with the British authorities in Aden. The rule of Turkey in this distant portion of Arabia had never been more than nominal. In order to preserve peace in the interior it became necessary in 1901 to come to an agreement with Turkey as to which tribes were to be governed from Constantinople, and which from Aden. A line of pillars would therefore have to be erected across S. W. Arabia through a country of which no maps existed.

In the autumn of 1901 a survey party was organized and dispatched to Aden with orders to extend the maps of the hinterland into the interior. Colonel Wauhope was placed in charge, and Capt. M. O'C. Tandy, R.E., was appointed his chief assistant. A strong staff of surveyors was chosen, including some who had served on previous expeditions with Wauhope, notably Lal Singh (now Rai Bahadur) and Sher Jung (now Khan Bahadur). Early in 1902 the British and Turkish Governments appointed special commissions to meet in Arabia and to settle the boundary. Wauhope was now selected to be the Chief British Commissioner, and his duties became political and diplomatic. He handed over charge of the survey operations to Tandy and for the next 2½ years he remained in Arabia, patiently endeavouring to settle disputes. It was on February 11th, 1902 that he first met the Turkish commissioners, Mustapha Ramzi Pasha and Ismail Saifi, and it was not till May 30th, 1904 that the boundary settlement was concluded. The first meeting took place at Dhali (height 5,180 feet, 75 miles inland from Aden), when the Turks requested Wauhope to become permanent president of the joint commissions and of the conferences. It was not a simple matter to determine a starting point for the boundary; for the Turkish claims were warmly opposed by the Arab Shekhs. The country had been governed under a system of tribalism and the several Shekhs were independent chiefs. Wauhope gave interviews to the Shekhs and examined the documents which they submitted as proofs of revenue payments from their villages. He described the chiefs as "intelligent and eager for a treaty, but very jungly." The negotiations were occasionally hindered by the Arab tribes attacking the Turks, and they were further interrupted by the Shekhs, who were in favour of British supremacy, fighting strenuously amongst one another. Many villages were bones of contention between Shekhs, and it soon became apparent that no progress would be pos-

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sible until maps had been completed. Some of the Shekhs helped the surveyors, but others obstructed them. The camel-men of the various survey detachments were continually being stopped, and forced into wrong directions. As soon as survey cairns and pillars and signals had been erected they were pulled down, generally by the local Arabs, but sometimes even by the Turks themselves. In December, 1902 Tandy was attacked and wounded by an Arab, and this delayed the surveys. Surveyor Lal Singh was fired upon more than once, and in January, 1904, Surveyor Abdul Jalil was killed. For two years disturbances were of frequent occurrence, and the Turks were powerless to restore order. Many questions of the boundary line had to be referred to London and Simla and Constantinople, and the periods spent by the commissions when waiting for replies were generally enlivened by local fighting. Wauhope's time was mainly occupied in endeavouring to promote agreements between the Turks and the Arabs, and many of these agreements, though successful for the moment, were subsequently broken. It was not till the commissions had been on the ground for two years that the boundary pillars were finally erected.

The boundary starts from the Arabian coast at the southern end of the Red Sea, opposite to the island of Perim, and from thence it runs in a north-easterly direction to a pillar near Kataba (height 4,400 feet), nearly 100 miles north of Aden. From Kataba the boundary is continued, but not demarcated, in a north-easterly direction across Arabia as far as the Persian Gulf. This delimitation placed the whole of Southern Arabia within the British sphere of influence, which thus includes the Aden hinterland, the Hadramaut, and Oman*.

Wauhope's last meeting with the Turkish commissioners was on board the Royal Indian Marine steamer *Dalhousie* in the Red Sea on June 13th, 1904. The boundary had at last been settled, the pillars built, the treaty and maps signed. Although the climate of the Highlands in the interior had been pleasant, the coastal zone had been oppressively hot, and Wauhope had suffered frequently from malaria. The long strain of the negotiations had also affected his health, and he felt that his constitution had been impaired. He proceeded to England on leave, and a year later, not having regained his normal strength and activity, he retired from the army at the age of 50.

After his retirement, Colonel Wauhope and his daughter lived at Alverstoke, on the Solent. In 1905 he was asked to write the article on Arabia for the forthcoming new edition of the *Encyclopædia Britannica*. During the years he had spent in the Aden hinterland he had made a study of the geography and history and dialects of Arabia,

* *Encyclopædia Britannica*, 11th edition, article "Arabia."

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and the article which he wrote has been recognized by orientalists as a scholarly and impartial contribution to a controversial subject.

A few years later he joined the Royal Geographical Society's Committee, as the representative of the India Office, for the revision of the spelling of geographical names, and his knowledge of the Arabic, Persian, and Pushtu languages rendered his advice valuable to the committee on the vexed questions that had arisen out of the clash of different systems of transliteration in Mesopotamia.

Services during the War, 1914–1918.—On the outbreak of war with Germany in 1914, Wauhope rejoined the army, and was at first appointed to the Ordnance Survey at Shrewsbury and Edinburgh. But when the garrison at Aden was attacked by Turkish forces, he offered his services to the India Office, and in July 1915 he was appointed political and military Intelligence Officer for S. W. Arabia. He had once more become a strong active man, but he was sixty years old in August, 1915, when he arrived at Aden.

Our forces were in contact with the Turks behind Aden, and there was continual skirmishing, which occasionally developed into fighting, but neither side was strong enough to inflict a decisive defeat upon the other. Wauhope endeavoured to get into communication with the Arab Shekhs who dwelt in rear of the Turkish positions, but as he was cut off from the land side by the Turks, his only means of communication were round the coast by steamer. He made many journeys up and down the Gulf of Aden and the Red Sea, halting at Perim and at the Arabian ports of Mokha and Hodeida. He also visited the island of Kamaran, situated in the Red Sea, 200 miles north of Perim. Ever since the boundary commission of 1904 he had had in mind the conflicting evidence of explorers concerning certain hills of Arabia; from an analysis of their narratives he had become convinced that two high mountains shown upon maps on the authority of different travellers were really one and the same. On one of his trips to Kamaran on intelligence work he took a theodolite, and from points on the island he was able to observe certain peaks inland. It is not on record whether his own observations helped him to come to a decision, but subsequently when he was revising the map of Arabia in the Survey of India Drawing Office, he moved the two explorers' routes nearer together in latitude, and by so doing he was able to convert their two separate mountains into one. The evidence available certainly seemed to favour this solution.

The Survey of India had become weakened during the war by the transfer of the greater number of its military officers and of many of its civil officers to military duties with the armies in France and Mesopotamia. As new maps of Arabia were wanted for the war with Turkey, the Surveyor-General asked for the services of Colonel Wauhope, as soon as he could be spared from Aden, and in June, 1916 Wauhope rejoined his old department. For the next

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2½ years he worked at map-compilation and map-drawing in the Survey Office at Dehra Dun. He brought Hunter's map of Arabia and of the Persian Gulf up to date, and he compiled some excellent maps of S. W. Arabia. His knowledge of languages enabled him to revise the spellings of geographical names, and he compiled two pamphlets on this subject for the use of map-makers, one dealing with the languages of Western Asia (Arabic, Persian, Turkish), and the other dealing with the Mongolian languages (Tibetan and Chinese). The senior Indian draftsman at Dehra Dun has written—"During Colonel Wauhope's re-employment in the Survey of India he once again won the admiration of all those seeking advice on geographical matters of which he possessed a vast knowledge; he was himself a neat draftsman, and the maps produced under his direction are monuments to his ability."

Wauhope remained with the Survey of India until peace was declared with Germany, and finally retired from the Government service in 1919. He returned to his home at Alverstoke, and his daughter rejoined him from her work in France. Eighteen months later they went to Switzerland for winter sports as they had done before; but Wauhope was no longer strong enough for a life at high altitudes, and he died suddenly, on January 23rd, 1921, of heart failure at Morgins in the Alps. An admirable appreciation of his life's work appeared in the *Times* under the title of "A Maker of Maps," and over the signature T. H. H. It closed with the words—"His many friends recognize a certain sad fitness about his end amidst the snows and peaks of Switzerland."

Colonel and Mrs. Wauhope left one daughter and one son; the former was her father's companion and created for him his home on the Solent; the latter entered the Survey of India, and has shown an hereditary aptitude for oriental languages and for dealing with frontier tribesmen.

Colonel Wauhope's services were brought to notice in dispatches on numerous occasions. He received medals for the Afghan War, for the Punjab Frontier, and for the Tirah Campaign, and five additional clasps. In 1895 he was made a Brevet Lieut.-Colonel, and in 1899 a Brevet Colonel. In 1896 he was awarded the C.I.E. for his services on the Pamir Commission, and in 1904 the C.B. and the C.M.G. for his services on the Arabian Boundary Commission.

As a surveyor Wauhope was of the accurate type; before descending from a hill-station he always liked to make quite sure of his results, and to leave nothing to chance. He accommodated himself with unfailing cheerfulness to the hardships of service and weather;

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when sleeping on the ground in the rain, sheltered only by a waterproof thrown over his theodolite stand, he not only did not complain, but he seemed to derive some satisfaction from such conditions.

His attachment to the classics continued through life, and it was seldom indeed that he was without his *Homer* and *Horace*; if they were not in his pocket on the hill-side, they were in his mule-trunk, or slipped into his theodolite box.

αἰὼν ἀσφαλὴς
οὐκ ἔγεντ' οὔτ' Αἰακίδᾳ παρὰ Πηλεῖ,
οὔτε παρ' ἀντιθέῳ Κάδμῳ· λέγονται μὰν βροτῶν
ὄλβον ὑπέρτατον οἱ σχεῖν, οἵ τε καὶ χρυσαμπύκων
μελπομενᾶν ἐν ὄρει Μοισᾶν, καὶ ἐν ἑπταπύλοις
ἄϊον Θήβαις . . .*

There are Survey stations in Southern India, which are over 125 years old, and which are still known as Lambton's stations, after the founder of the Triangulation of India. And there are survey stations in Northern India which have for over 90 years been venerated as Colonel Everest's stations. Wauhope's surveys were carried out in wilder countries, but there are many important mark-stones and cairns on the hills of Asia, from Arabia to the Pamirs, which will be known to posterity as Wauhope's stations.

* "A secure time fell to the lot neither of Peleus the son of Æacus, nor of the god-like Cadmus; howbeit these are said to have had, of all mortals, the supreme of happiness, who heard the golden-snooded Muses sing, one of them on the mountain, the other in seven-gated Thebes."

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CORRESPONDENCE.

THE TECHNICAL TRAINING OF ENGINEER OFFICERS.

DEAR SIR,

I have read with interest the " Professional Note " communicated in the January number of the *R.E. Journal* by the Commandant S.M.E., and am glad to note that the question of sending young R.E. officers to Cambridge as a permanent arrangement is under consideration at the War Office.

It is stated in the memorandum that it has been published with a view to drawing criticisms from those opposed to the idea, and consequently it might seem that, as I entirely approve of the suggestion, no remarks from me would be called for.

As, however, the length and scope of the proposed course have not been dealt with, and as I have had exceptional opportunities of considering the subject, I venture to think that my views may be of some value.

For nearly a quarter of a century it has fallen to my lot to closely study the question of the training of engineers. For seven years I was at the head of the R.I.E. College (Cooper's Hill) and for many years subsequently I was a member of the committee appointed by the India Office to select candidates for the Indian Public Works Department, and was thus in touch with all the engineering colleges.

I have also kept myself in close touch with the curriculum of the R.M.A.

My first remark, therefore, is that the engineer cadets leaving the Academy could certainly be made to reach a standard as to Mathematics, Mechanics, Experimental Physics and Chemistry equal to that of the Intermediate Examination at the end of the first year of study at engineering colleges, though I am doubtful whether all would attain the " First Class Honours " level.

The question, then, is as to what the future course should be.

My view is that, on leaving Woolwich, the next year should be spent at the S.M.E. with a view to (1) a complete *military training* as laid down in the memorandum (p. 23); (2) a thorough *survey course*; (3) a complete course of *field engineering and fortification*; and (4) *signalling*.

Following this they should go to Cambridge for the Mechanical Tripos Honours Course and should study there for two years.

Here, as pointed out in the memorandum, they would receive a thorough grounding in the theories of engineering as also in the mathematical, mechanical and physical sciences that form their foundation, but it cannot be too clearly recognized that on completion of this course the students are not yet engineers, but have merely received the necessary *theoretical* training enabling them to take advantage of future opportunities of mastering their profession.

Lastly, they should return for yet another year to the S.M.E., with a

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view to a short refresher course of military training, and a thorough insight into the work that may come their way in the ordinary course of their service; for instance:—the construction and maintenance of buildings (barracks, hospitals, etc.), camps, military roads, water supply, the usual machinery used in peace and war, searchlights, fortification and military bridging.

I am quite satisfied that nothing short of the four years' course above indicated as required after leaving Woolwich would suffice to bring our young engineers to the required standard, and I feel certain in my own mind that the sandwiching of the two years' Cambridge course between the two S.M.E. courses would prove to be far away the best solution of the problem.

JOHN W. OTTLEY, *Colonel (late R.E.), M.I.C.E.*

REVIEWS.

MANUAL OF MAP READING AND FIELD SKETCHING, 1921.

The new manual is a much more ambitious production than its predecessor. Indeed, it is inevitable that the appearance of large scale gridded military maps and of photographs taken at every conceivable angle, should call for a corresponding increase in the study of their possibilities. Many of the additions, such as the chapter on the new grid, are therefore indispensable. On the other hand, it seems doubtful whether the examiner will not profit, even more than the average student, from much of the new matter; or whether there is a call for the inclusion, even as appendices, of projections, land forms, and spelling of place names. However that may be, the manual is a mine of information not only for the map-reader, but for the surveyor.

As a matter of arrangement, dictated by the effort to restrict to Part I all that is essential to the military training of an N.C.O., I think it a pity that chapters on copying, enlarging and reducing maps and on military reports, or reconnaissance, have been moved from Part I to Part II. They could with advantage have taken the place of Chapters IX, "Maps of the British Empire," and X, "Special Military Maps," in Part I. It is also common to find N.C.O.s and men who develop a marked talent for panorama drawing, an exercise which does much to educate and interest the individual in ground forms, and the chapter on this subject might have found a place in Part I.

Apart from the re-arrangement, and the expansion of matter noticeable throughout, Part I follows much on the lines of the last edition. The first noticeable addition is that (on p. 30) describing the numbering of the international 1/M Map Sheets and of G.S.G.S. Maps. The inclusion amongst the plates of indexes to the W.O. 1/20,000 of England and to 1 in. to 1 mile Ordnance Survey Popular Edition would have been welcome. The next addition, and the most important one in the book, is the chapter on the new "Grid," which is very clearly explained. It is regrettable, however, that this admirable system has been added to

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by introducing a small square number in each kilometre square. This number represents the kilometre co-ordinates of the S.W. corner. To add these numbers here and there, say every third square, is useful. To place them in every square may seriously interfere with the map detail, and is an undeserved reflection on the average intelligence. A much more serious point, however, is the insertion of commas and dashes in the co-ordinates themselves. A reference such as A 5473 is all-sufficient (within a 10-km. square). To make it into A 5, 4—7, 3 will imply such cumulative troubles in telegrams, reports, letters, and printed and typed orders that the rule will, inevitably, be honoured more in the breach than the observance. If the first number did not always refer to the same unit, or the individual co-ordinates were ever given to different degrees of precision, the case would naturally be altered.

Part II deals with more advanced subjects and with work in the field. Critics will no doubt differ in their opinions as to the inclusion of some of these subjects in a manual of map reading and field sketching, but none will find much quarrel with the matter itself.

The chapter on plane tabling is a particularly full and detailed guide to an art which should be taught to every Cadet. There can be no guide to map reading more efficacious than actual survey on the ground.

The chapter on the use of aeroplane photographs is a useful addition, especially for the Royal Regiment.

In Appendix II, "Notes on the Projection of Maps," p. 190, appears the statement that "there can be no single grid" upon a "polyconic series of maps." It is no wiser, as a general rule, to mix one's projections than one's drinks; but so long as no sensible error is to be found in maps on any one projection, a grid on any other projection, similarly free from distortion, may be overprinted. Such an arrangement is far from ideal and implies as a corollary the recomputation of the trigonometrical data in terms of the superimposed grid, but it has been done, notably on the Italian Front.

Part II will make many a surveyor regret the inadequacies of his education.

The plates and figures are very well reproduced. It is curious to note that the words "Military Edition" appear above the samples of Ordnance Survey Maps. There is no special Ordnance Survey "Military Edition" and the samples refer to the ordinary series on sale to the public.

The book is of handy size and well bound.

H. St. J. L. Winterbotham, *Lieut-Colonel.*

THE PRACTICAL ELECTRICIAN'S POCKET-BOOK AND DIARY, 1922.

London. S. Rentell & Co., Ltd. Price 3/-.

This handy little volume attempts fairly successfully to cover a very wide field. The practical electrician of to-day is a very talented person indeed if he has a sound knowledge of the multifarious branches of electrical engineering treated of in this book.

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In order to compress into some 560 small pages a comprehensive survey of the whole subject, vigorous sub-editing has apparently been necessary; opinions will naturally differ as to the relative importance of the various subjects, but it would appear that the process of condensing has been applied somewhat unequally.

Fifteen pages have been allotted to the Control of Lighting Circuits. The subject is treated very fully with a wealth of diagrams. It is questionable, however, if the various switching arrangements are used to any extent. Five pages are occupied with the description of one particular make of electric clock, no mention whatever being made of the other excellent types in use. Electric plant is dismissed somewhat summarily, whilst what used to be called Prime Movers amongst them can only muster a few pages. Oil and petrol engines account for two or three pages only, illustrated by a small cut of a quite unrepresentative type. The section dealing with the electric plant is little more than an enumeration of the various types.

The tables on pages 126 and 127 on the power required to drive various machine tools are somewhat misleading, as the limits for each type are so wide as to be of little or no value. For example, it is scarcely helpful to be told that a circular saw requires 2-5 h.p., if of medium size, and 10 h.p., if large. Installation work is treated fully, but overmuch space is given to the description of numerous lead-covered wire-systems which appear to differ in little more than name. Some 18 pages are devoted to Electric Welding, a subject of somewhat limited appeal: here, again, one particular system is given prominence to the exclusion of other equally meritorious systems.

The pocket-book, undoubtedly however, fills a want, and will prove (and has proved) exceedingly useful to practical electricians such as foremen, wiremen and works electricians. The Diary portion might with advantage be considerably larger or be omitted altogether; as it is, it is too cramped. The book is clearly printed on good paper, the size of page being convenient for the pocket: in common with all books of the type, however, it tends to develop *embonpoint* with the passage of the years.

R. CHALMERS BLACK, *Capt., R.E.*

ALPHABETS OF FOREIGN LANGUAGES TRANSCRIBED INTO ENGLISH ACCORDING TO THE R.G.S. II. SYSTEM.

(London R. Geographical Society). Price 7/6.

This pamphlet, the second of the R.G.S. Technical Series, is the work of a Permanent Committee appointed with the object of determining the proper spelling, for British official use, of foreign place-names. It should become a reference book for all time, and will have achieved invaluable service if it succeeds in reducing to order the very confused spelling of many of our foreign maps and reports. Seventy-nine languages are treated, and much information is added, showing the varieties of pronunciation peculiar to each.

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THE OFFICIAL HISTORY OF AUSTRALIA IN THE WAR OF 1914–18.

VOL. I. THE STORY OF ANZAC. THE FIRST PHASE. *By* C. E. W. BEAN. Published by Angus and Robertson, Ltd. Price 21/-.

It is the intention of the Australian Government to publish twelve volumes of this Official History, of which six, describing the work of the A.I.F. in the various theatres, are to be written by Mr. C. E. W. Bean. Other volumes will deal with Sinai and Palestine, The Australian Flying Corps, The Royal Australian Navy, etc. The book before us, the first of the series, contains 660 pages, 111 maps and 56 illustrations. It deals with the outbreak of the war, the raising of the A.I.F., its training in Egypt, including the first Turkish attack upon the Canal, the landing at Anzac, and the operations in Gallipoli up to the end of the First Phase of the campaign on 3rd May, 1915. It is written in a popular, but by no means a journalistic, style, and its interest is enhanced by the free publication of names and units. Every action is clearly explained by the help of abundant maps and photographs, and a description of each is also given from the Turkish point of view, as after the armistice Mr. Bean spent a week in Gallipoli with a senior officer of the Turkish War Office and with him discussed the fighting at every point. The book is extraordinarily interesting, and will remain a valuable record. The Australian nation is to be congratulated on its historian.

F.E.G.S.

NOTICES OF MAGAZINES.

REVUE MILITAIRE SUISSE.

No. 9.—*September*, 1921.

The War in Anatolia.—Colonel Feyler, who spent many weeks with the Greek Army in the field in Asia Minor during thes ummer of 1921 gives an account, in the original article, of the chief features of the Greco-Turkish conflict. He is of opinion that the campaign in Anatolia furnishes lessons of considerable value to the military student; lessons more diverse in their nature than those usually met with in military history. He thinks that there is as much to be gained by a study of the Greco-Turkish campaign in Asia Minor as there was in the Boer War of 1899–1902, which, in its time, excited deep interest in military circles. Colonel Feyler starts with an investigation into the political causes which led to a declaration of war in the Near East, and then proceeds to discuss some of the military problems which have had to be handled by the Greek General Staff. At the date when Colonel Feyler wrote his article (August, 1921), the War had passed through three distinct phases. The first stage was the campaign of 1920; the chief object of the operations at this stage was to relieve the pressure on the British troops in the region of Constantinople, where they were in danger of being pushed back to the Black Sea. During this phase the Hellenic forces occupied the western portions of Asia Minor, and, in co-operation with British troops, also the southern shores of the Sea of Marmora, the Dardanelles regions, and the country about Brousse and Ismid (Nicomedia). The

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second phase began in the spring of 1921 : the ease with which success was obtained in the first phase led the Greek General Staff into the error of being over-confident and the mistake was made of dividing the Greek Army into two distinct groups, one of three divisions and the other of four divisions, which were separated by an intervening space of 125 miles, a separation which prevented the two groups lending one another effective support. Moreover, the divisions were much below establishment ; the strength of the companies being only 70 rifles. Faulty strategy, coupled with the tactical weakness of the forces employed, resulted in the attack by the northern group of divisions on Eski Chehr being abortive, whilst the Divisions of the southern group, which had proceeded some 60 miles E. of Afiun Karahissar, ran the risk of being cut off from their base. On the termination of these operations the Greek General Staff reviewed the whole position of affairs, and prepared an appreciation of the situation ; the conclusions arrived at are briefly set out by Colonel Feyler. At this juncture, Greece was threatened with isolation in the sphere of international politics ; the Western Powers offered their mediation, but as a condition precedent demanded that the region of Smyrna should be evacuated by the Greeks. The Government at Athens was not willing to comply with this condition, and replied with a *non possumus*. In these circumstances, it became important that the Greek Army should not meet with a reverse in its further operations. The subsequent strategic plans of the Greek General Staff were, in consequence, drawn up to meet a situation in which the dominant factor was politics, home and international. Experience had shown that it was an expensive game to attempt to drive the Kemalist soldiers from their fortified positions, and it was, in consequence, felt that a preferable course would be by manœuvre to draw the Turks out of their strong positions and, having done so, to compel them to fight in the open. Such was the philosophy which dictated the movements carried out by the Greek Army in the third phase of the campaign in Anatolia ; many new problems came under the consideration of the Greek General Staff in connection with this phase of the War. Colonel Feyler calls attention to the main points connected with them in his article, and briefly describes the plan of campaign adopted for the Greek Army : it consisted in a concentric movement of four columns, which, advancing from a base line some 125 miles long from extremity to extremity, eventually converged on to a line some 60 miles in extent in front of the centre and right of the enemy. The plan was a bold one, and in view of the fact that the several columns were for a time isolated from one another some risks were run. However, the Greek General Staff had obtained the correct measure of its enemy, and the course of events which succeeded this move fully justify the measures adopted.

Finance Arrangements of an Army.—Capt. L. J. Joyet calls attention in the original article to the large sums in cash, which under normal arrangements existing in Switzerland were withdrawn from circulation and held in hand for the Swiss troops mobilized during the Great War. He points out that the interest on the money so immobilized ran into some millions of francs, and suggests that the waste this implies can be obviated by the introduction of a system of payments by cheques. He outlines a scheme to meet the situation.

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Military Bridges.—The original article consists of a review by Colonel Lecomte of an article on military bridges which appeared in the number of the *Revue du Génie Militaire* for June, 1921. The article in question has been reprinted in pamphlet form and is published by the Imprimerie Berger Levrault of Paris.

NOTES AND NEWS.—*United States of America.*—A special correspondent calls attention to some of the recent changes in the American Army: *inter alia*, it has been decided to form Tank Units in the National Guard, of which there are to be four battalions of three companies each (light tanks). The twelve companies will be raised independently in each of the twelve States which have taken up the scheme. A movement has also been started in some of the States to raise Air Force Units in the National Guard; the First Observation Squadron, Tennessee National Guard, has already come into existence, and measures are on foot in connection with the creation of similar units in the National Guard of New York State. It is stated that by degrees, and without attracting too great public attention, measures are being introduced, the object of which is to assimilate the National Guard of the several States with the regular Army; and in the new Army organization, the National Guard Divisions will take their place side by side with the regular Divisions. As a preliminary measure, the National Guard Units have been given numbers in sequence on a general list, although they will continue to bear their former designations also.

Portugal.—Economy in military expenditure is the order of the day. The funds voted for the upkeep of the Portuguese Army have been cut down in drastic fashion, and Portugal will have to be content with an Army of four Divisions in place of the eight Divisions it has hitherto been maintaining.

W. A. J. O'MEARA.

REVUE MILITAIRE GÉNÉRALE.

October, 1921.

Albania.—By GENERAL H. SALLE.—The relations of the Jugo-Slavs, Greeks, Italians, and indirectly the remaining European powers, with Albania are intimately connected with the decisions which will be arrived at by the Conference of Ambassadors, or the Supreme Council, in regard to the future status of that country. The writer lived in Albania for fifteen months, 1917–18, as military commander and civil administrator of Goritza, for which reasons he hopes he may be considered qualified to instruct public opinion to some extent on that little-known region. Like the rest of the Balkan Peninsula, its physical features are steep rocky mountains, intersected by tortuous valleys. None of its rivers are navigable, nor do the estuaries provide sea-ports. The few roads existing are in a deplorable state except where for military purposes certain sections have recently been repaired. The only highways are the Via Egnatia from Durazzo to Constantinople, via El Bassan, Okrida, Monastir, Salonika and Kavalla, and another running north from Santi Quaranta through Delvino, Liaskoviki and Goritza to join the former between Okrida and Monastir. Albania comprises the northern part of the ancient Epirus, the southern part of Illyria, and part

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of Macedonia. The inhabitants, in common with the Greeks, claim descent from the Pelasgians but differ from the rest of the Balkan races in language, creed, and manners and customs. Whether Bey, pasha, or herdsman, the Albanian is always a " Skipetar " or free man, recognizing no authority but the head of his clan, and, despising manual labour, is as rough and uncompromising as his own mountains.

After the defeat of Pyrrhus, king of Epirus, that country, with Illyria, submitted to Rome, roads were made through the mountains towards the Danube, Greece and the East, and Latin colonists introduced agriculture into the valleys and plains. Various ports, amongst them, Salona (Valona) and Dyrrachium (Durazzo) sprang up, and the Albanians retreated to the mountains, to descend periodically to pillage and lay waste the plains. In the Middle Ages the Venetians used the ports in their traffic with the East. The Slavs attempted unsuccessfully to subdue the country ; the Turks, who followed them, found allies who helped them to overthrow the Serbs at Kossovo, but who, under "Scanderbeg," prince of the Albanians, and as popular with Moslem as with Christian, resisted every attempt to impose on them Turkish rule. On Scanderbeg's death in 1467 the Albanians nominally submitted to Turkey but retained their own customs and laws. Many adopted the Moslem religion, while others emigrated to Sicily or Southern Italy, but never forgot their mother-country. Francesco Crispi, the Italian statesman, was one of the latter. In adopting Islam, the Albanians did not altogether forsake their old religion and the worship of saints and Christian emblems, and in their forays respected both Moslem and Christian monasteries, even endowing them with part of their booty. Their conversion saved them their lands, and many entered the Turkish military and civil services, in which not a few rose to the highest positions owing to their bravery and intelligence. Partly as a reward for these services, partly owing to the impossibility of coercing them, the Albanians were excused the payment of taxes and compulsory military service, and enjoyed other favours. In 1878 the " Albanian League " was formed to resist the stipulations of the Berlin Congress which assigned to Montenegro certain districts in the north of Albania inhabited by the powerful tribe of Mirdites and Malissores, who in a country of Moslems and Orthodox Christians had remained Roman Catholics—external aggression alone could consolidate the various tribes.

The Turkish revolution of 1908 was at first well received, the " Committee of Union and Progress " and the Albanians being united in hatred for the reforms introduced by Abdul Hamid and the Great Powers, but when the Young Turks tried to levy taxes and take a census, the *entente* ceased. Insurrections broke out and were repressed by the Turks with characteristic cruelty. In 1912, during the Balkan War, Albania did nothing to help Turkey beyond affording asylum to the Turkish generals Ali Riza and David Pasha after their defeats by the Serbs at Kumanovo and Monastir. Essad Pasha, who was an Albanian, surrendered Scutari to the Montenegrins, and in 1913 Turkish resistance collapsed. At the Treaty of London of 1913 Albania was declared independent under the government of the Prince of Wied, who adopted the title of " Brat " or King of Albania, but his authority hardly extended beyond the outskirts of his capital of Durazzo, and even this was due to

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the influence of his Minister for War, Essad Pasha. Profiting by the weakness of the Albanian Government, the Greeks invaded Northern Epirus (Southern Albania) and, on the pretext of protecting their co-religionists, installed themselves in Goritza, pillaging and burning the Moslem villages. In December, 1914, the Prince of Wied absconded. Essad Pasha seized the government and declared for the Entente. The Greeks at Goritza permitted of direct correspondence between the emissaries of King Constantine and Austria and Germany. At the end of 1914 the Italians, before they had joined the Entente, occupied Valona, a strategic position which has been termed the Gibraltar of the Adriatic. At the end of 1915 Essad sheltered the debris of the Serbian army, and allowed of its transport by the ships of the Allies to Corfu, where it was reconstituted for services later at Salonika. The Albanians paid for their generosity by undergoing invasion by Austrians and Bulgarians. At the end of 1916, when Constantine had shown himself a declared enemy to the Allies, the French occupied Goritza, driving out the Greeks and cutting their communications with Austria, and in 1917 joined hands with the Italians who had by that time spread over the whole South of Albania. At Goritza an autonomous government was set up, the so-called "Republic of Goritza," in reality controlled by a French general and staff. As the French commander, the writer found the Albanians, with few exceptions, brave and loyal. Certainly they were given bread, employed for pay on various work, and treated with justice and honesty, methods foreign to the Greek, Austrian and Bulgarian, and it may be hoped that the French occupation will not be forgotten. After the Allied successes of 1918 the Bulgarians and Austrians were driven out of Albania; at the time of the armistice only a few French and Italian battalions remained in the country. and in 1920 the last of these were withdrawn. A provisional Albanian government was constituted at Tirana which sent representatives to the Peace Conference, and Albania has been admitted to the Society of Nations.

During their occupation of Goritza the French raised a Corps of some 800 Albanians as gendarmes, with French officers. Each company was commanded by chieftains of the clan, and all rendered good service subject to the conditions that Moslems and Christians are not intermixed in the same company, and that, if clan companies are employed side by side in the same operation, they must be led by French officers or they would turn their arms against each other, instead of showing rivalry in courage and endurance. In considering the future status of the country the social organization of the Albanians must not be lost sight of. The family is the basis; these are united into tribes or clans, the head of which is a Bey, generally the owner of land which he can parcel out to the families of the clan. Nearly every family and clan has its private vendetta, which may be composed for a time by a very powerful chief, but is bound to break out again. Few Albanians reach an advanced age. Again, the Roman Catholic detests the Moslem, the inhabitant of the North and Centre hates the dweller in the South, Moslem abhors Christian. No clan, family, or religion seems to be capable of uniting the whole population. Essad Pasha tried to do so and fell in Paris at the hand of an assassin, whether the victim of personal vengeance or political animosity, is not known. Since Scanderbeg,

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national unity has ceased to exist, and for many years to come the national individualist mentality will oppose fusion, unless it is secured by threat of foreign invasion. The people are prolific, and owing to the poverty of the country many emigrate to the United States, where they congregate and retain their own language and customs, and send home their savings. From these considerations it seems unlikely that Albania can exist of herself, and that to acknowledge her independence is to condemn her to anarchy. Thoughtful Albanians recognize that they need assistance from one or more foreign powers to develop their ports, roads, railways and industries. Jugo-Slavs and Greeks, their neighbours, can hardly aspire to this rôle owing to their limited means and ancient antagonism to the country. The former might, however, render assistance in the North near the Montenegrin frontier, where should pass their proposed railway from the Danube to a possible terminus at Alessio or St. Jean de Medua, via the valley of the Albanian river Drin; the Greeks covet Goritza, Argyrocastro and certain districts in the South of Albania, but the Albanians will at present listen to neither. It seems probable that America, England or France may accept a mandate, which will, however, entail a heavy outlay and lead to complications with Italy, who intends to be mistress in the Adriatic, and for this reason might be given the mandate over Albania. Italy has many interests in the country, held from 1914 to 1920 the port of Santi Quaranta, also that of Valona, the best in Albania, Delvino, Argyrocastro and all the South of Albania, where she spent much money and even opened schools where the Italian language, as well as the Albanian, was taught. The mere suggestion has awakened Albanian nationalism, and a Council of Regency was nominated at Lushina in Central Albania in opposition to the Council of Tirana, which was suspected of favouring Italy. The movement even developed into a series of assassinations, some by nationalists, some by partisans of the Italians, and then into repeated attacks on isolated Italian posts, forcing the Italians to concentrate in the coast towns which were evacuated one by one, till Valona only was garrisoned. On 2nd August, 1920, an agreement was signed at Tirana between Italy and Albania, by which the Italians definitely agreed to evacuate Valona except the island of Sasseno, which commands the harbour, and recognised the independence of Albania. The latter engaged to defend her own integrity against all foreign interference (Greek or Serb) and to assure to Italy certain economic advantages. This amounts to an apparent diplomatic triumph for Italy disguising a check to her arms; the future will show whether the evident aim of the policy, *i.e.*, the control of the Adriatic, will find accomplishment. The full independence of Albania is now recognised; it remains to delimit her frontiers, but the form of her government is not assured, nor her economic development. Whatever form the government takes, it seems that a commission of international control may be necessary to preserve the land from internecine feuds, support the government, protect minorities and develop its economic resources. The writer considers that if any one nation could succeed in the task it would be France, and recommends French commercial and industrial interests to make the most of their opportunities.

F. R. REYNOLDS.

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THE "CANADIAN" PHOTO-TOPOGRAPHICAL METHOD OF SURVEY.

By CAPT. AND BT.-MAJOR E. O. WHEELER, M.C., R.E.

THE principles of the "Canadian" Photo-topographical method of survey are perhaps not so well known as are those of map making from aeroplane photographs. The essential difference is that the latter method depends on the photo being taken with the optical axis of the camera pointing vertically downwards (or being "re-distorted" to produce that effect), while the former requires that the axis be truly horizontal—in other words, a true perspective of the country to be mapped is used. I have called it the "Canadian" method: for, although it was invented and has been used elsewhere, it has been elaborated and far more extensively applied in Canada than in any other part of the world.

Plotting by stereo methods from pairs of photographs, while based on the same principle of perspective, involves the use of totally different methods for obtaining points, and is not in any way connected with the "Canadian method;" the following is a brief explanation of the latter, which was first tried in India with the Mount Everest Expedition in 1921.

Instruments.—The instruments required are the camera, a small theodolite for fixing the position and height of the camera station and measuring the direction of the "orient points," and, in the case of little known country, but which contains triangulated points (such as the neighbourhood of Mount Everest), a light plane-table to assist in the identification of those points.

Camera.—The form of camera adopted consists of an inner metal box open at one end and with the lens fixed at the other; a pair of cross levels are fixed in the sides of this box to enable the instrument to be levelled in two positions. For this purpose it is fitted with a levelling base similar to that on a theodolite. The inner box is protected by an outer wooden cover, at the back of which is a movable carrier, worked by a screw and butterfly nut from the outside: in this the plate holder is placed, and, after the slide is withdrawn, the plate can be screwed forward against the open end of the inner box, thus securing constant focal length and, when the camera is properly levelled, verticality of plate. Slots in the wooden cover allow the bubbles to be read.

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In the centre of the edges of the inner box sharp notches are filed, so that they appear in each photograph taken and form reference marks from which the "principal" and "horizon" lines (see *Diagram*) can be measured. $4\frac{3}{4}$ by $6\frac{1}{2}$ plates are used: the lens adopted is a Zeiss Tessar f 6·3, series II b, *anastigmat*, to cover a 4 in. by 5 in. plate, which gives a wider angle for a shorter focal length (6 in.) than would be possible if the proper lens for the plate were used. The angle of view is 51° by 36°. By stopping down, the larger plate is fully covered, and the photograph, being almost free from distortion throughout, is practically a true perspective. At f 45, the stop usually used, the focus is definite from about 15 ft. to infinity. A heavy yellow screen (Wratten "G" filter on optical flats, five times) is used to obtain good contrast and colour rendering with a backed panchromatic plate. (Wratten and Wainwright found to be suitable). This necessitates exposures of from 3 to 5 seconds on a bright day, at f 45. Exposures are made by means of an ordinary between-lens shutter with antinous release. To improve the brightness of the image, a shade is invariably used over the lens. The camera, together with 11 plates (1 in the camera), note-books, pencils, etc., is carried in a stout leather case, arranged to carry on the shoulder like a knapsack; the whole weighing about 30 lbs.

Theodolite.—The theodolite is a 3 in. vernier instrument, reading to minutes, which fits in two parts in a wooden box. The tripod, which is collapsible and serves for both the camera and the theodolite, consists of three two-section legs, measuring 20 in. closed and 3 ft. 4 in. open, which fit on a metal tribrach carried with the theodolite. In use, the instrument is steadied by filling a 3-cornered canvas bag, which is suspended from the joints of the legs, with stones, and if necessary piling stones inside the legs up to the tribrach. The theodolite box and legs are carried in a canvas case similarly to the camera, and weigh about 27 lbs.

On the Mount Everest Expedition, an 18 in. square plane-table was used, of which the edges were arranged to fold back so as to form a pack 18 in. long by 9 in. wide, and which fitted on the camera levelling base. The plane-table was held open and steady while in use by means of two removable wedge-shaped battens sliding in grooves underneath the table. The paper was cut at the joints so as to fold under with the edge of the table.

Triangulation.—Triangulation may be carried out separately or concurrently with the detailed survey, using either the 3-in. or a larger instrument. The former method is preferable. Camera stations are interpolated by readings with the 3-in. instrument to three or more fixed points. The interpolation may be computed, but it is usually sufficiently accurate to plot them graphically, first plotting the rays on a piece of tracing paper, fitting the rays to their respective stations, and pricking the point through. For this

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purpose an "arm protractor" of (including the arms) about 12-in. radius, reading to minutes by means of a vernier, is used.

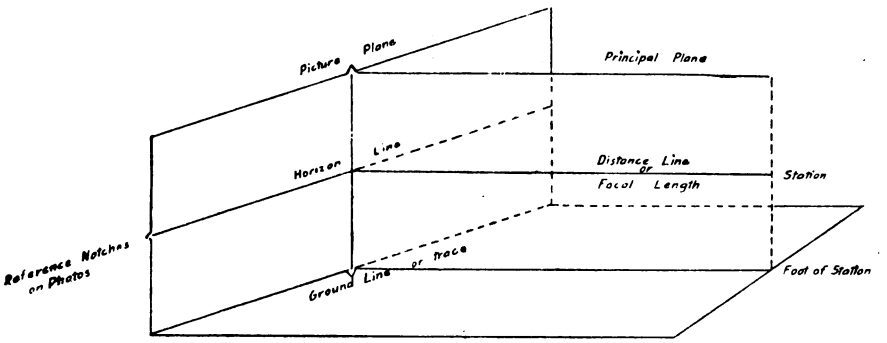

DIAGRAM NO. 1.—*Illustrating Terms Used.*

Orient Points.—In each photograph there must be an "orient point," either a triangulated point or one whose direction with reference to a triangulated point has been measured, which is plotted on the plan by means of the protractor.

Plotting "Traces."—To enable the "Trace" (horizontal projection of the picture-plane) of the photograph to be laid correctly on the plan, and to enable heights to be measured on the photograph, it is necessary to know the positions of the "principal line" (vertical centre line) and "horizon line" of the photograph. These are measured with reference to the notches which appear on each photograph, the camera level bubbles being used throughout the season in a constant position; this position is found by experiment before the work is begun, as described later on.

Having the direction of a point in the photograph (the "orient point") laid out on the plan, and knowing the focal length or "distance line" of the photo or enlargement in use for plotting: and knowing that the trace of the photograph falls at the length of the distance line from the station and perpendicular to it, it is easy, by measuring the distance along the horizon line of the photograph from the orient point to the principal line of the photograph, to draw the trace of each photograph in its proper position on the plan. In practice this process is expedited by the use of a celluloid "tracer" on which the horizon and distance (principal) lines and station point are previously drawn, and on which the orient points are marked as required. By laying the station point over the station on the plan and the orient marked on the tracer over the corresponding ray drawn on the plan, the positions of the distance line and trace are at once given. This is done for all the photographs.

Plotting Points.—When the traces have been laid on the plan and all points required to be plotted have been projected vertically

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downwards or upwards to the horizon line of the photograph and then transferred to strips of paper (the principal line being marked on each

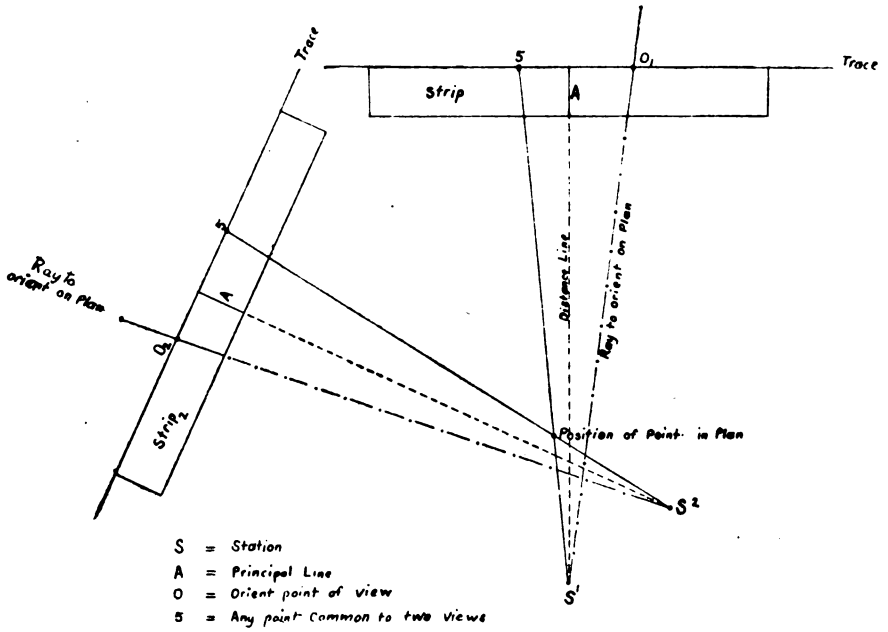

DIAGRAM NO. 2.—*Illustrating Plotting Points in Plan.*

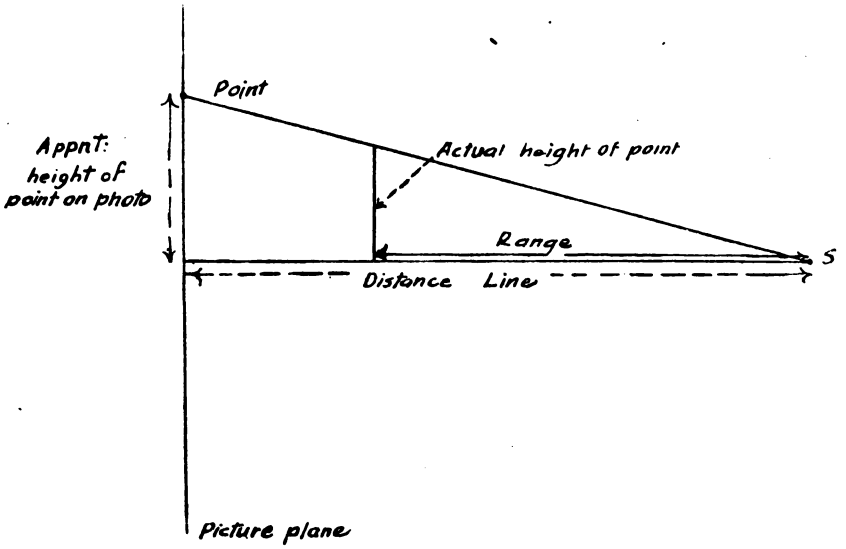

DIAGRAM NO. 3.—*Illustrating Computation of Heights.*

strip and registering with the principal line of the photograph) and the strips have been laid in their appropriate position on the traces

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on the plan, obviously the intersection of the rays joining the projections of the same point on two or more photographs of the same terrain (taken from different stations) will represent the position of that point on the plan; and the better the intersection of the rays the more accurate will be the position fixed. This process is carried out for all the points required to be plotted.

Heights.—To obtain heights. The distance line of the photograph is known and the apparent height of the point above or below the horizon line of the photograph can be measured on the photograph. The range of the same point can be measured on the plan, and the actual height of the point above or below the horizon line, *i.e.*, above or below the station from which the photograph was taken, can be computed by means of similar triangles.

In practice an instrument is used to expedite this process. It consists of two fixed arms to represent the base and "height" of the fixed triangle, *i.e.*, the distance line as base and the apparent height of a point as "height," the latter being projected on the *principal* line of the photograph and transferred to paper strips as in the case of points in plan. There is a sliding arm, carrying a scale, which can be placed at the range of the point on the plan; and a revolving arm radiating from the station on the plan which, when placed at the apparent height of any point as shown on the paper strip on the fixed height arm, obviously reads the actual height of the point on the sliding arm scale, when the latter is placed on the point in plan. A mean of heights thus obtained from two or three stations is taken.

As many points on ridges, valleys, etc., as are required are thus fixed and their heights computed. Contouring can then be done by examining the various photographs covering the same area.

Method of Squares.—One further process is extremely useful for plotting lakes, streams and similar figures contained in, or nearly in, a horizontal plane, provided the difference in height between the station and figure to be plotted is known.

This is the method of "squares," and consists in drawing the perspective of a network of squares over the figure to be plotted; and a corresponding set of squares on the plan. It is usual to lay the side of the squares parallel and perpendicular to the distance line on the plan (*i.e.*, vanishing in perspective at the principal point) though any direction (such as North or South) may be used. The relation between the sides of the square in plan and on the photograph and their position on the plan, is dependent on the length of the distance line and the difference in height between the station and the plane of the figure to be plotted. This is most easily obtained graphically, and is usually done once for all (for photos of the same distance line) on the "perspectometer." To construct the "perspectometer," horizon and principal lines, and the perspective

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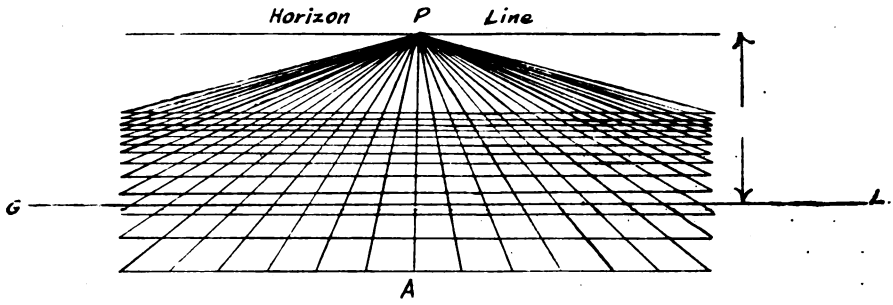
of a network of squares vanishing at the principal point (the intersection of the horizon and principal lines) are drawn on paper and



P = Principal point
A = Perspective of squares with sides parallel and perpendicular to the distance line,
B = Rays to the same squares from the Station
h = Difference in height of stn. & figure to be plotted

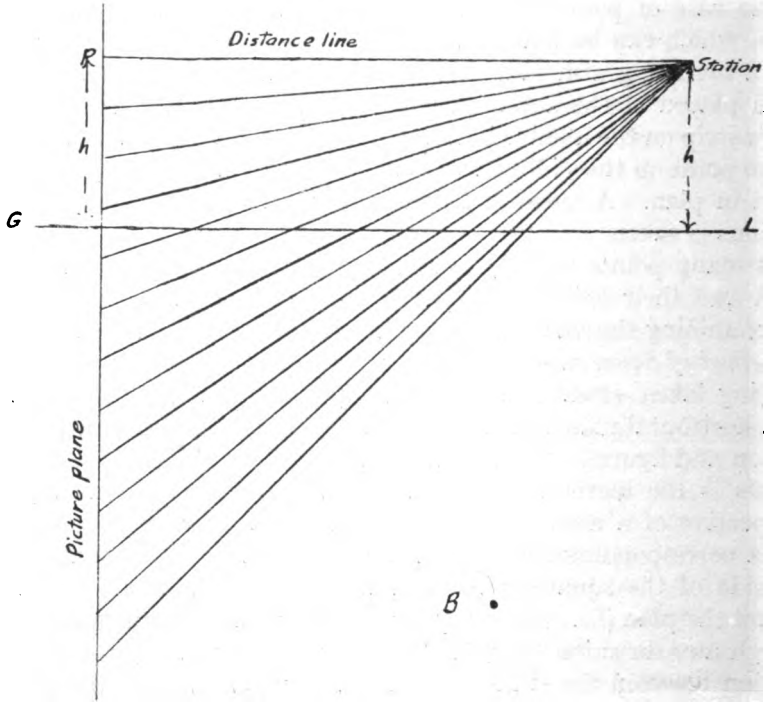


DIAGRAM NO. 4.—*Illustrating the Perspectometer.*

photographed on to plate glass. The instrument is placed in position over the photograph and the appropriate squares required for plotting the figure transferred to the plan, their size varying with each par-

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ticular case and dependent for a fixed distance line only on the difference in height. These may best be obtained by drawing the "Ground Line" for the particular photograph and figure under consideration, on the perspectometer. The ground line will fall on the perspectometer at a distance (in "scale feet") below the horizon line equal to the height of the station above the figure to be plotted, and on the plan, in the trace of the photograph. The size of the squares in plan may be obtained from *Fig. A, Diagram IV*, at the intersection of the Ground Line with the squares: and their position relative to the trace, from *Figure B*, at the intersection of the Ground Line with the picture-plane. The outline of the figure enclosed in the squares is then transferred square by square to the plan.

Testing Camera.—Before starting the season's work it is necessary to ascertain the readings of the camera level bubbles which will make the plate vertical, and will make the true horizon line approximately cut the notches filed in the camera box; and before plotting, to ascertain the focal length or distance line of the prints or enlargements to be used, and the exact position of the horizon and principal lines with reference to the notches appearing on the prints. In the case of a contact, the distance line is equal to the focal length of the camera; but as it is usual to use an enlargement, it is best to measure the distance line actually on the enlargements to be used; obviously a fixed focus enlarging camera must be used to ensure constant scale and distance line.

Verticality of Plate.—Tests for verticality of plate are carried out by placing the lens of the camera and a mark some 300 to 400 yards in front of it in the same horizontal plane by means of a level, racking a plate glass reflector forward against the inner box in the same place as the plates will occupy, and by means of the levelling screws of the camera, making the image of the mark coincide with the cross hair of the level.

The readings of the "fore and aft" bubble are then noted. This is done for the two positions of the camera.

Horizon and Principal Lines.—To ascertain the position of the horizon and principal lines and to calculate the focal length (or distance line) three marks are put up and levelled as above, and photographs taken: in the vertical position of the camera so as to include two marks, and in the horizontal position all three, the transverse bubble being kept in the centre of its run during the operation. The line through the targets will then represent the true horizon in each position of the camera, and its position with reference to the notches may be noted. If the true horizon falls inconveniently far from the notches, the process may be repeated with the transverse bubble appropriately out of centre.

The horizon line of the photograph in one position of the camera

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being transferred to a photograph in the other position, will give the principal point of the photograph at the intersection of the two lines; these lines will not necessarily be perpendicular to each other, but a line through the principal point *perpendicular* to the horizon line of each photograph will be the principal line of that photograph, the principal and horizon lines being perpendicular to one another by construction.

Focal Length.—To obtain the focal length or distance line, the angle between the outer marks for each position of the camera is measured with the theodolite (angle W), and the distance from each mark to the principal point measured on the photograph. This can most conveniently be done in feet on the plotting scale.

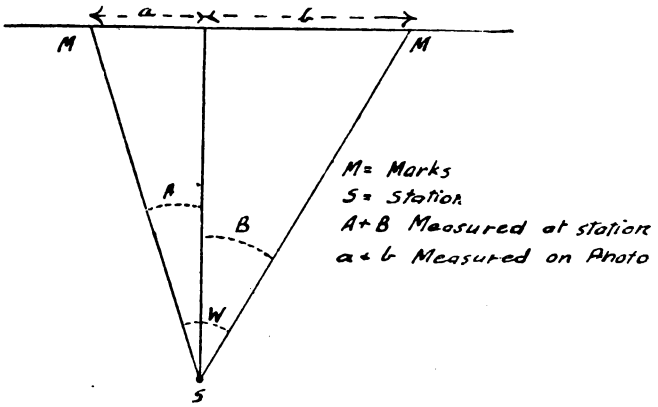

DIAGRAM NO. 5.

The distance line may then be computed from the formula:—

$$\tan (A+B)=\tan W=\frac{\frac{a}{f}+\frac{b}{f}}{1-\frac{ab}{f^2}}$$

where f = the distance or focal length.

Field and Office Work.—At the station in the field, photographs are taken of all country required to be mapped. A good overlap is allowed to avoid plotting too close to the edges of the photographs, and in case an orient point is for any reason omitted. Notes of exposures and angles are kept in the field, and the work plotted on return to headquarters It is convenient sometimes to develop plates in the field and to make sufficient prints to assist in the identification of mountains, etc. Development is done by time and can be carried out almost anywhere. Otherwise no drawing or office work whatever is done in the field. Full advantage is therefore taken of a short

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mountain season and there is no question of sketching detail with numbed fingers, as is the case with the plane-table at high altitudes.

Advantages of method.—The method is particularly suited to rugged country and the more rugged the country the more favourably it compares with the plane-table. The precision, in ordinary hill country is equal to that of the plane-table; and in high, rugged country is likely to be greater, for with the aid of several photos of the same country under his eye at the same time to assist in the identification of points, and the advantage of being able to work in the comfort of an office, the draughtsman is able to sketch in detail at his leisure and without having to trust to his memory to interpret intricate topography. It should be clearly understood, however, that the method is a method of surveying detail only, and is equally dependent with the plane-table on an accurate frame-work.

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DARDONI.

By MAJOR A. H. BELL, D.S.O., O.B.E., R.E.

IN a recent army examination one of the papers dealt with a part of the Trans-Indus situated between the Kurram and Tochi Valleys. One of the places referred to in this paper is Dardoni. It is possible that a short account of the origin and growth of this place may be of some slight interest to others besides the Sapper whose lot it was to get it built.

For many years before the last Afghan War peace was kept on the Indian Frontier by means of the Militia Force which owed its inception to Lord Curzon. The Headquarters of the Militia which garrisoned the Tochi Valley, known as the Northern Waziristan Militia, is at Miramshah, a place on the North side of the Tochi Valley, about forty miles by road west of Bannu. The Militia post consists of a large fort with high walls of sun-dried brick, surrounded by a barbed wire entanglement. The Civil part of the post contains the living quarters and offices of the Political Agent, and the Military part barracks for several hundred men and a comfortable Officers' Mess and Quarters. Outside are the well-kept gardens of the Political Agent and Militia, watered by an irrigation channel taken from the Tochi some miles away.

In 1915 an incursion of outlaws and raiders took place from Khost a few miles to the north. A force was hurriedly sent up from Bannu, and after defeating the enemy with great slaughter, near a Wazir village called Dardoni, settled down under the north wall of the Militia post to await more peaceful times.

A kind of defended camp, with partly dug-out huts for Officers and men and a perimeter wall, was built there. The best features of this camp, from a constructional point of view, were the rapidity with which the work was done and its small cost. From a sanitary point of view, the camp was not so successful. Its area was very circumscribed, horses had to be kept in it at night, there was no proper water supply, men died of pneumonia and fever was common.

As a result of medical agitation, it was decided in 1916 that a new camp with a proper water supply should be built at some distance from the old one.

The force to be provided for consisted of two battalions of Indian Infantry, two squadrons of cavalry, two sections of a Mountain Battery and various details.

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As water was the all important factor, two trial wells were started, one about 1½ miles from the Militia post, at a higher elevation on the plain or "dandi" on which it was built, and the other about two miles further away. The latter was soon abandoned, whilst the former was carried on till water was reached through a soil like soft rock at a depth of 120 feet.

The site for the camp, to be known as "Dardoni" after the Wazir Village, was therefore chosen on the gently sloping "dandi" between the Militia post and the well, about one mile from the former and to the north of it.

It is about 3,100 feet above sea-level, and distant in a straight line about nine miles from the Afghan border and 25 from Matun, the chief village of Khost; about 100 miles from Ghazni, the nearest Afghan town of any importance to which the track up the Tochi valley leads; 120 from Kabul; 30 from Makin in Mahsud Country, and 32 from Bannu (but 41 by road), the nearest rail-head. It is about three miles from the north bank of the Tochi.

It was decided that the camp should take the form of three large squares laid out on a common diagonal to facilitate flank defence. The largest enclosure, to accommodate personnel, was 680 yards square; the next, for animals, was 250 yards square, and the third, which was intended for the convoy which periodically brought up supplies from Bannu, was 100 yards square.

Various examples of hutted camps exist on the Frontier, which have been laid out in an unsatisfactory manner; Tank and Thal may be cited as instances. Buildings have been put up far too close together, radiation from the mud walls which surround one on all sides increases the heat and produces an atmosphere of oppression.

At Dardoni the barrack huts were spaced with large intervals round the perimeter. The Officers' huts were built on the sides of a square near the centre of the large enclosure, which was traversed by three metalled roads running North and South and two running East and West.

It was naturally arranged that all the material needed for the construction of the buildings should be obtained locally. All walls, with a few exceptions, were made of sun-dried bricks, which were moulded near the irrigation channels some two miles away. Nearly all the buildings were made of a standard section, 18 ft. wide, with a central row of pillars, 2 ft. square at 9 ft. central intervals, the side walls consisting of panel walls 1 ft. thick, between pillars 18 in. square, opposite the central pillars. The roof covering was of the ordinary type on the Frontier, namely about 4 in. of mud, covered by 1-in. layer of mud plaster. The mud was laid on a double thickness of grass matting which was supported by thin poles (ballis) at 6-in. central intervals. The poles spanned the distance between the rafters, the ends of which rested on the pillars.

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The rafters and the poles could be purchased at Miramshah from tribesmen who bring them down the Tochi from the well wooded Shawal District to sell at Bannu. Grass mats could be bought locally and mud for the bricks was everywhere.

The barrack huts, when they were finished, were most uninviting and met with almost universal disapproval. A type of hut which had been put up at Tank had by advice been taken as an example. There were no windows, but a space of about 2 ft. was left open at the top of the panel walls to admit of air and ventilation. This result was certainly obtained, but a frousty atmosphere is as much prized by the Sepoy as it is by the Tommy, and after many complaints half the number of openings were closed by grass panels or were built up altogether. Probably by this time there are glass windows. The floors were originally of mud, but the medical authorities objected to dust, so eventually all the floors in living-rooms were paved with roughly squared stone blocks, which could be quarried about three miles away.

The Officers' huts were more elaborate. The central pillars were omitted, and the rafters supported by struts instead; they had proper windows, fireplaces and stone floors.

Each of the three enclosures was surrounded by a mud wall, 6 ft. high, and a wire entanglement, and the largest enclosure had a block-house at each corner.

The huts intended as hospital wards were more elaborate than the barrack huts. They were 20 ft. wide and the roof was supported by trussed beams. The floors were of concrete, and there were verandahs on both sides.

The water supply was all derived from the aforementioned well. A circular shaft was dug a few feet away from the well and connected to it by a tunnel. This shaft was lined with stone and a direct-acting steam pump (to be duplicated later) was fixed on a concrete platform at the bottom, the suction-pipe going through the tunnel into the well. The boilerhouse and a reservoir were built near the top of the well with a double-storied stone blockhouse alongside for protection.

The reservoir was built of local lime-stone masonry in cement mortar in two compartments with a ferro-concrete roof, the floor being at ground level.

From the reservoir water gravitated to the camp and was laid on to standpipes fixed at convenient centres, to water-troughs in the animals' and convoy enclosures, and to various taps in favoured buildings, such as kitchens of Officers' Messes.

The supply, when finished, was much superior to that in many cantonments in India which have been in existence for a hundred years or so, *e.g.*, Nimach in Central India, where, until recently, at any rate, water was only obtainable from two or three wells;

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and Nasirabad where water was drawn from a system of wells in leather bags by bullocks, which, in times of drought, when the water-level was very low, had to work night and day. The water fouled by the bullocks gravitated to a reservoir several miles away, from which it flowed through a pipe of insufficient diameter to the cantonment two miles distant, where the delivery was inadequate and intermittent.

When the camp was nearly completed, it was decided to add a company of Sappers and Miners to the Garrison, and additional huts were built ; owing to the liberal spacing of the huts in the first place there was no difficulty in providing the room required.

Latrines were of a superior type ; they were of C.G.I. and bought ready-made with a view to their being re-erected elsewhere should the camp be moved in course of time further up the valley, and as being more sanitary than latrines of mud-brick. They were put up in four groups, two outside the north face, and two outside the south face of the large enclosure, with an incinerator in the middle of each group.

At the beginning of the Afghan War in May 1919, the camp was practically complete as originally planned. For a few days it appeared likely that Nadir Shah would advance from Spinwam towards Dardoni and invest it, but luckily for Dardoni he selected Thal for his attentions. As a measure of precaution the walls of the animals' and convoy enclosures were flattened out, and all the animals were picqueted in the large enclosure at night.

Later in the same year an ice-machine, which had been lying in the camp for a year whilst sanction for its erection was being granted and refused by two apparently antagonistic branches of the Staff at Simla, was hastily erected by a devoted R.E. Officer, whose health gave way under the strain of working continuously throughout the day in a hot summer for several days in succession.

Shortly afterwards electric-light engines were installed, and fans and lights were then available in the hospital and Officers' Quarters.

Later Commanders than the famous mountaineer, under whose auspices Dardoni was started, considered the arrangement by which the main source of water supply was outside the perimeter of the camp to be a dangerous one, so a new well and another reservoir were made inside the walls.

In the actual construction of the camp labour was, as usual, the great difficulty. There was none obtainable locally. A contract for the whole camp was first arranged with a Hindu contractor at reasonable rates. He started well, but soon came to the conclusion that he was not getting enough out of his contract and refused to continue.

Various small contracts were then given out to Punjabi contractors, but they were all unable to collect sufficient labour, and made very

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slow progress. Eventually a contract was arranged with a Hindu at rates much exceeding those originally allowed, and, although he made fair progress, his work was not as rapid as he had promised it would be. His workmen, who all came from India, were timid and unhappy, they were always trying to run away to Bannu, the nearest railhead, but were always relentlessly and quite illegally sent back.

One of the greatest difficulties was in transporting the mud-bricks ; they had to be moulded near an irrigation channel about two miles from the camp and were carried thither somewhat grudgingly by camels and mules belonging to the S. and T. Corps.

In retrospect, it is clear that a camp of this kind, situated in an out-of-the-way spot, accessible for wheeled traffic only by a road which is liable to attack at any time, where food is dear and water difficult to get, where workmen have to live in a protected area, should be built by organized labour under military discipline, such as a Works Company, of which there were several working on the Frontier during the Waziristan operations last year, and that special arrangements for transport should be made by allotting S. and T. troops for that purpose only.

From an announcement in the papers a few weeks ago, telling how a convoy had been attacked between Datta Khel and Mohammad Khel, it appears that the Upper Tochi, which was abandoned at the beginning of the Afghan War, has been re-occupied. So it may well be that Dardoni is destined soon to relapse again into its original mud, and to be re-born under a new name a few miles further from the Indus but nearer to Ghazni and the heart of Afghanistan.

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SOME EXPERIENCES OF AN ENGINEER OFFICER WITH THE SALONIKA ARMY.

By COLONEL-COMMANDANT G. WALKER, D.S.O.

(*A lecture delivered at the S M.E., Chatham, on* 3. 3. 21).

(*Concluded.*)

SURVEY.

7A. The first survey troops to arrive in Salonika were the Topographical Section. The only existing maps were the 1/200000 and 1/2500000, both of Austrian origin and both very inaccurate. These were what were issued to the troops on first arrival and they were of very little use. The French had started a trigonometrical survey from a base measured on the Vardar plain with an astronomically determined azimuth, and were pushing a triangulation through the country. The British, in January, 1916, commenced a survey by measuring a base on Hortiack Plateau. This base was 1,355 metres long, measured with a 300-ft. steel tape which had seen much wear in Gallipoli and had not been tested with any standard subsequently; no corrections were applied, and the mean of two measurements only was taken. No astronomical observations were taken for latitude or azimuth.

This base was extended to the Langaza plain to join up with the French system.

The triangular error for 44 triangles, 3 of which were not closed, averaged 36 secs., the greatest being 124 secs.

Co-ordinates were computed on a rectangular basis and the French value for the side on which the British closed was used in computations.

The White Tower in Salonika was taken as the initial station and the French co-ordinates for this accepted. When the work reached Langaza a new base of 3,562 metres was measured. On the completion of this work the triangulation was carried eastwards to connect with the Naval system at Stavros.

No azimuthal check was obtained, as the Naval system was based on geographical co-ordinates, and no attempt was made to convert them to the rectangular system used by the Army. More or less at the same time a triangulation was commenced in the Struma valley where a new base was measured. This was carried westwards and

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southwards to Langaza and Stavros, and large errors were found in closing with these places.

The triangulation was subsequently extended to the Doiran area and Katerini. In January, 1917, a Survey Company was formed at Salonika, and the work put under an officer of the Royal Engineers.

Difficulties were constantly arising about the value of the points determined in the operations outlined above. Many points determined from each of the three bases had three different values, and it was realized that the work done was not sufficiently accurate to extend from, in case of an advance, or to attempt any artillery work, as was being done in France. To give examples, differences of as much as 200 metres existed between the lengths of co-ordinates and the triangular errors were often large (up to 2 minutes) and often only two angles of a triangle had been observed.

It was consequently decided to start a new network as a basis on which to recompute the old work.

In June, 1917, a new base, 6½ miles long, was measured in the Langaza plain with apparatus borrowed from the French. Two measurements were made and corrections made for temperature and level.

The difference between the two measurements was 6 cm. Observations for latitude and azimuth were made. The net-work covered the whole British area and the average triangular error was 7 ft. 4 in. for 64 triangles; geographical co-ordinates were computed. The initial azimuth was that of the south end of the base line. The initial latitude was that of the White Tower, as given on the Naval Chart, and this was carried through the triangulation. It only differed from that taken at the south end of the base by 1 ft. 8 in.

The geographical co-ordinates were converted into rectangular co-ordinates. All the old triangulation was recomputed, using, wherever possible, the value of the sides of the new triangulation.

Eventually, when we were able to join up with the enemy's triangulation in Bulgaria, the British and German results were very close.

Topographical Work.—When the Army first reached Salonika every division was ordered to make reconnaissance sketches of the area it occupied. This work fell very largely on the R.E. Field Companies. The work was done with plane tables but it was found most difficult to connect it up, as the survey authorities at the base could not give any true north and south line to work on, test compasses, etc. The reason for this is clear from the description of the way the original survey was initiated. I mention this point to show how inaccurate arrangements for survey work affect even the advanced troops at times. Ultimately the Survey Company at

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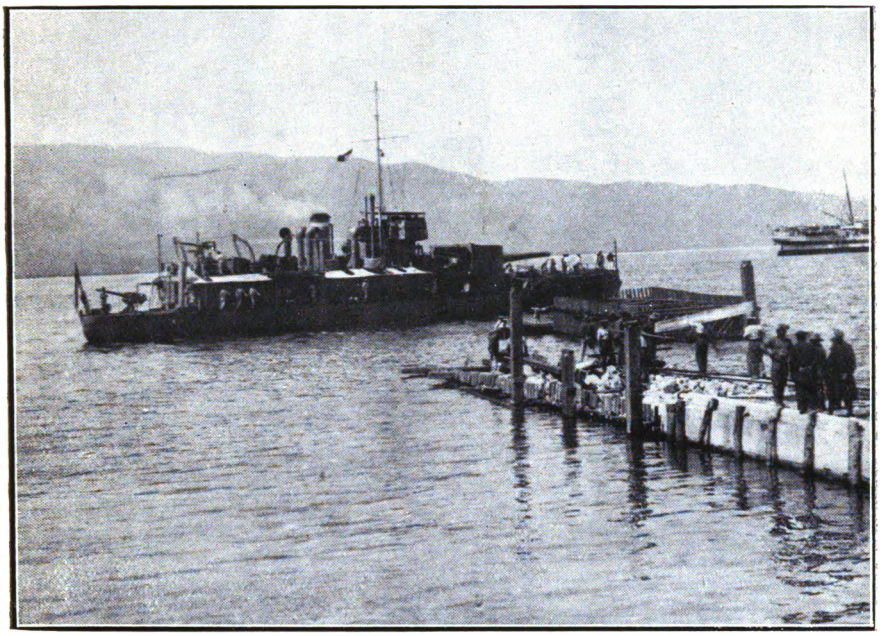
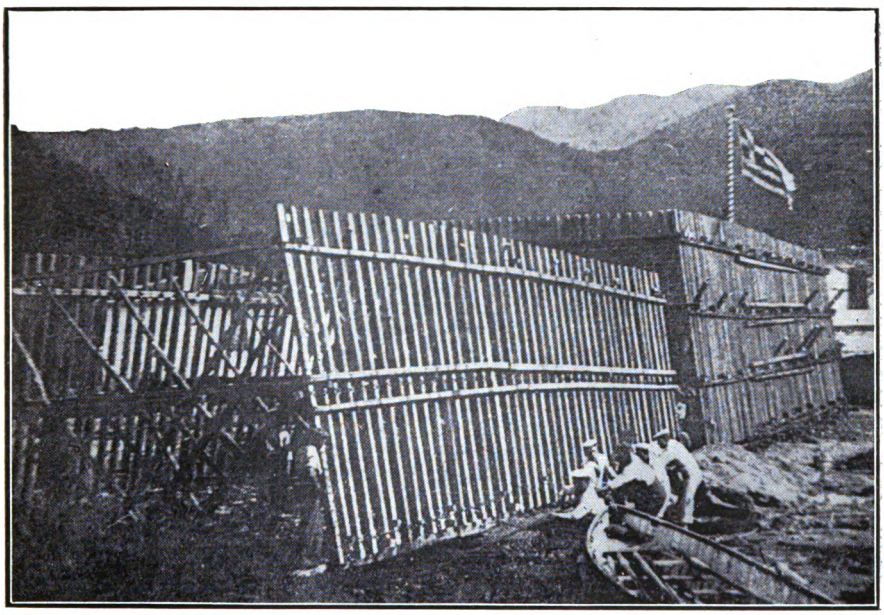
STAVROS PIER.





General Construction of Cribs. Ready for Launching.

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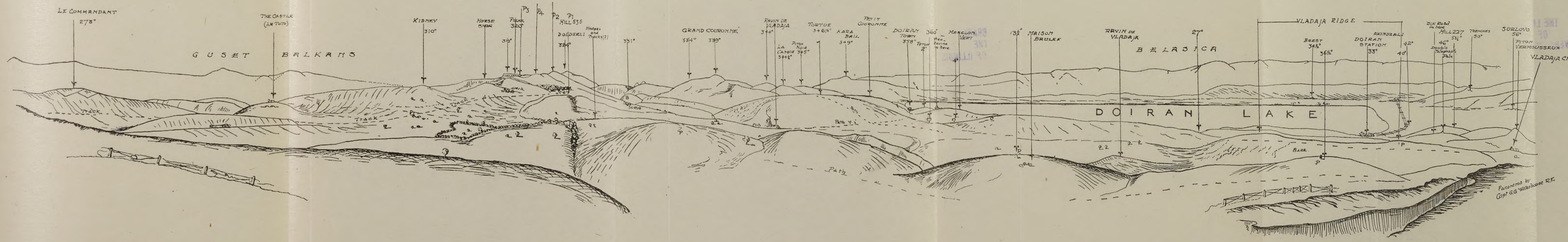
PANORAMIC VIEW OF FRONT FROM HILL 420.

TRUE BEARINGS.



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Salonika filled in their triangulation with extremely good and accurate topographical work.

At first the British maps were based on French data.

They were issued in two series :—1/50000, 1/20000.

A certain number of 1/10000 sheets were produced later of ground not covered by the French.

In January, 1917, a complete new survey was started in two series :—1/20000 for front areas, 1/50000 for back area.

These sheets were extended beyond the enemy lines by means of air photos adjusted to a skeleton forward triangulation.

Location of Hostile Artillery (*Sound Ranging and Flash Spotting*).—The results of this work in Macedonia are specially interesting as they show how useful it can be if carefully organized, even in a hill country, where artillery have every facility for concealment.

The work was carried out from locations on the existing maps which were good and accurate (1918) and not from triangulated points, as there were no surveyors available for this latter method.

It was found that the observer should have artillery as well as survey knowledge, and that if individuals of this sort were not available, the work should be done by two officers, one of whom should be an artillery officer ; the results obtained being then sifted by a third man who controlled several parties.

The 12th Corps front was divided into three areas for the work :—

(1) " P " Ridge to Doiran (*see* attached panorama sketch) ;

(2) " P " Ridge to Vardar ; (3) West of the Vardar.

The results in (1) and (2) were as follows :—

(1) Thirty-nine Batteries existed, as found from reconnaissance after the advance. All had been located—32 within 50 yds., 1 within 100 yds., 6 over 100 yds.

(2) Forty-seven Batteries were located out of 57 subsequently found, that is, 82 per cent.—25 within 50 yds., 14 within 100 yds., 8 over 100 yds., total, 47. Ten were not located, but of these, nine had been spotted from one set of observations only, but this was not considered sufficiently accurate for record as actual location. The actual natures of 215 guns were also identified between Doiran and the Vardar by these methods.

These results were very satisfactory and depended almost entirely on the accuracy of the mapping. To give point to this remark I may say that in 1917 application was made to me by the Artillery for the loan of a theodolite for range-finding purposes by triangulation.

I lent the instrument, but warned the borrower that, unless he was sure of the accuracy of the location of his observing stations, the results would be useless. The result was not satisfactory because the maps available were not sufficiently accurate.

The moral of the above story seems to be clear, namely, that good mapping is essential in all military operations. Laymen are so apt

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to pin their faith absolutely on the accuracy of any map, just because it is a map, that the issue of bad maps is a serious source of danger. I think I have also indicated how the inaccuracy of survey work produces trouble even in the front-line fighting areas.

From a purely engineering point of view too great stress cannot be laid on the necessity for accuracy. A good map saves the engineer an enormous amount of reconnaissance work in the location of routes for rail and road and also as regards water supply.

In Macedonia no geological survey was available, and there was no time to make one. If such a survey had existed it would have saved the engineers a great deal of labour.

DISEASE.

8. The diseases common in Macedonia were chiefly:—

Malaria.
Dysentery.
Typhoid.
Smallpox.

It was from the first two that the Army chiefly suffered.

The last three were dealt with by inoculation, and I never came across a case of either cholera or smallpox; though there were several scares about the former.

Malaria was our principal enemy, not excluding the Bulgar. The country and inhabitants were rotten with it, and the area abounded in the Anopheles mosquito. The worst places were the Struma, Batkova and Vardar valleys, but the mosquito was to be found wherever there was water, even in the Hill Country. As far as I know personally, the Army at large went to Macedonia in complete ignorance of this, and no protection arrangements were provided when we went out. On our arrival in January, 1916, we heard rumours, and I remember saying to General Milne that, if this was a true rumour, we should lose more men from malaria than from several general actions. He agreed, and in his Division precautions started as soon as possible.

They consisted principally in the collection of materials for the building of mosquito-proof huts in the most dangerous localities. We were then engaged on the Birdcage line and there was no idea of going any further; in fact, we were confidently expecting to be attacked where we stood. There were great difficulties in getting materials, especially mosquito-proof wire-netting.

In June, 1916, when we moved forward in the middle of the malaria season, we left our few mosquito-proof huts and occupied the Vardar-Doiran-Struma line with no other protection than one square yard of cotton mosquito-net per head.

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The result of this move, which was unavoidable, is shown by the Hospital Returns. I myself was in hospital at Malta with 22,000 other patients, most of whom were suffering from malaria and most of whom came from Salonika. We were only those who were so bad that it was thought advisable to get us out of Macedonia for recovery, and were additional to those in hospital and convalescent camps in that country. A very large proportion, of course, returned to their units eventually, and I only state the figures to give an indication of what the Salonika Army suffered from this disease.

When the troops reached their new positions, anti-malaria work started afresh and consisted of draining, cleaning and housing in mosquito-proof huts or dug-outs. Veils and gloves were also issued for night work and a mosquito-proof *tente d'abri* for two men was issued. It may be of interest to note that ultimately the men of gun detachments and nurses and orderlies in hospitals worked at night in veils and gloves. Such protection was impossible for working parties, however.

In fact, protection against the mosquito at night for fighting troops is a most difficult problem. The malarial mosquito only works at night, and even then movement is a considerable protection to a human being. The sleeping man is the easy victim.

The Bulgars, and eventually the British, retired during malaria months to the higher land, and left the valleys and marsh areas as much as possible.

The point I want to bring out is that it is absolutely essential to take time by the forelock in dealing with disease. You may not be able to do the best thing, but every little helps, and this little must be done quickly. Further, that the study of the diseases of the country and the way to combat them is essential for a soldier, especially for the Engineer, as upon his shoulders falls most of the actual work. Engineers and Doctors must work hand in hand in this matter and unless they do disaster will follow.

A few details may be of interest. Clearing ground for a distance of 400 yds. outside camps is a great assistance. All streams should be cleared or canalized to preserve a quick flow (1/100 is a useful grade). Swampy areas should be drained, and pools near camps oiled with paraffin. When possible, in standing camps everyone should sleep under protection. In huts all apertures must be closed with wire. In tents protection is almost impossible, but it is easy to treat dug-outs. The great difficulty in hot countries is to get the troops to sleep under protection. They say it is too hot. Good discipline and education are the best cures for this failing.

Dysentery.—This disease in a very bad form is endemic all round the Balkan coasts and up country. The British Army did not suffer from it very severely, owing to the stringent precautions taken.

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The great enemy is the fly, so that fly-proof latrines (with self-closing seats), larders and cookhouses are essential. Absolute cleanliness as regards food and the person must also be impressed on everyone. The items mentioned above were all R.E. work and entailed a great deal of labour and arrangement.

Every unit, however small, was supplied with a fly-proof larder or meat safe. Another precaution taken was the careful burning of all excreta, whether of men or animals. This entailed the building of incinerators of various patterns. The units as a rule built their own with our materials.

HOSPITALS.

9. Following a description of our bodily ailments there should follow logically some remarks as to the provisions for curing them.

To fully describe the Salonika hospitals would require a book. My remarks shall therefore be very short. The first thing to be said is that they were excellently good. Nurses and doctors vied with each other to make us comfortable and happy, and I should know, as I was several times a patient.

The following hospitals were in being at Salonika :—

"General," (1,600 beds), 4 hutted, 19 tented.
Stationary, (600 beds), 7 tented.
Convalescent Camps, 11, mostly tented.

They were situated principally round the base or within 14 km. of it, but there were hospitals also at Sarigol, Guvesne and Lahana.

The above do not include the Clearing Stations in the Corps and Divisional Areas. All these hospitals entailed an enormous amount of engineer work, such as approach roads, water supply (by pipe or well), pumps, lighting (E.L. in some cases), ward huts (when hutted), hut kitchens, latrines, other accessories (always), operating theatres (sometimes).

The operating theatre is the central feature of a military war hospital. In Salonika we nearly always had them in huts at the Clearing Stations. We built one for each of the C.C. Stations at Karasouli and Janes and, I am told, thereby saved a good many lives.

PIERS.

10. A great deal of work had to be done at Salonika to facilitate the unloading of the ships. The difficulty was the shallowness of the water and the depth of the mud—the latter varied from 40–60 ft. The former necessitated long piers, and even then the stores had to be trans-shipped in lighters.

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At Salonika itself five piers were constructed west of the railway station. They were "piled" and the superstructure was simple timber work. Lines of rail were laid on the decking.

(1) Malta Pier, length 178 ft., width 16 ft., water 7 ft.
(2) Gravesend Pier, length 1,021 ft., width 19 ft., water 7 ft., pier head 286 ft. long.
(3) New Pier, length 590 ft., width 22 ft., water 15 ft.
(4) Hay Pier, width 33 ft.
(5) Marsh Pier, length 1,169 ft., width 43 ft., water 7 ft.; head 269 ft. long.

At Stavros a very interesting piece of pier construction was carried out. Stavros was the supply port of the troops in the Southern Struma area. These troops were at first supplied entirely by sea, and it was essential to construct a pier for supply ships to lie at in all weathers. The site was selected by the Navy and the construction was commenced under Major (then Lieut.) J. H. Waller, D.S.O. an officer of one of the field companies of the 10th Division, who had had previous experience of building fishing piers on the Irish coasts.

The method of construction was unique as far as I am aware. The pier was built in lengths of crib work of suitable height according to the depth of water, of convenient length for launching, and wide enough at the top to carry the designed superstructures. Actual dimensions were 22 ft. deep, 50 ft. long, and 25 ft. broad.

The cribs were made of 4 by 4 timber, cut near the site by Greeks with supervision by Sappers of the 17th Field Company, R.E. They were lashed together with wire and the bottoms were lined with wire netting. They were then launched on ways and towed to their positions by a monitor. They were then sunk in position by being gradually loaded with Greek labourers, who were marched on from the shore. These men were withdrawn as the stone-filling was put in. Finally the cribs were crowned with a concrete superstructure. This was made by reinforced concrete beams round the tops of the crib spars, connected at 15-ft. intervals by horizontal tie beams.

The concrete went down to water-level (there being little or no tide).

The whole of the top of the pier was brought up to level with ballast and covered with torpedo net which was securely tied to the concrete on the weather (south) side.

This was then covered with gravel. The object of the net was to prevent the stones in the crib being washed bodily upwards and out of place by the wash of the sea. In a heavy sea the waves would break green over the pier and also force their way under the concrete and throw the stones right out of position.

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After a gale the surface of the pier over the netting had to be remade. The whole work was completed in two and a half months, the first section being finished in a month.

The pier took 30,000 tons of stone to fill it and was in position in 1919.

The attached Photographs generally illustrate the work.

Besides the above there were subsequently five shallow-water piers for lighters constructed in 1918. These were made of steel caissons sunk in position and loaded with stone.

Before leaving this subject, a word should be said about the Salonika Base. A British force of five Divisions was landed at Salonika, that is to say, a force four times as large as that employed in Egypt in 1882, and to this was joined about the same number of French troops. That is an unprecedently large overseas force of all arms.

This Army was based upon an ill-kept and ill-equipped town inadequately supplied from the oversea base, and it was operating in practically a desert country.

The initial facilities for landing men and material were entirely insufficient and the water in shore was so shallow that piers of great length had to be built.

No arrangements were made to co-ordinate the port facilities to the positions of the troops of various nationalities, with the result that the streams of traffic from the landing-places crossed and recrossed each other in the most inconvenient way.

The confusion that obtained must always remain an object lesson to those who witnessed it.

It is a lesson which teaches the absolute necessity for proper organization of a sea base, both as regards landing facilities and leading away stores from the beach, when two or more nationalities are operating together.

It may here be added that throughout the campaign the numbers of technical troops were inadequate. Besides the R.E. field companies with the Divisions there were at first, I believe, only five Army Troops and one Base Park companies, R.E. These were added to later by the arrival of two more Army Troops companies and the formation of various railway units as the railways were extended.

The country provided no manufacturing facilities, skilled labour was scarce, and the unskilled undisciplined at first. These difficulties were bad enough at the beginning, but when the Army moved forward they were greatly increased.

If we are to look for a cause for all this, I think it can be found in the fact that no one at home or abroad really realized what the requirements of a large modern army operating in a roadless and almost desert country were likely to be.

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Ropeways.

11. Although plant was available, ropeways to overcome transport difficulties in the Hill Country were not used at the beginning of the campaign.

A ropeway was projected in 1916 from a point on the Seres road to gain access to the S.E. flank of Kotos Mountain and give communication with the right flank of a defence line in this area. The approach road from the south was surveyed and commenced, but the ropeway was eventually abandoned, as easier communication was procured from Hortiack. Subsequently ropeways were constructed at Karamudli and Krusoves and at the Dranista Mines (two).

Karamudli.—This was a single line between Karamudli and Arakli—operated by petrol engines of Marine type, 7 h.p. Total length, 7,845 ft.; rise, 640 ft.; capacity, 70 tons in 8 hours; speed, 210 ft. per minute. It was used for supplies and munitions for the military posts in the Krusa Balkan and obviated mule-haulage up the very steep Baisili hill. It was initiated in November, 1917, and completed early in 1918.

The Krusoves line was a gravity line to supply troops on Ahinos lake below the Krusoves hills. No details are available of its construction.

Dranista Mines.—The details of these ropeways were as follows :—

(1) Carriers' capacity, 160 lbs. each; speed, 250 ft. per minute; single line; length, 300 ft.; fall, 57 ft.

(2) Single-line gravity; carriers and speed as (1); length, 1,500 ft.; rise, 178 ft.

Besides the above a much more important line was projected between Bralo and Itea Pier. It was intended to carry stores from the port of Itea to railhead at Bralo, but the line was never constructed.

Details of Design.—Speed of rope, 360 ft. per minute; diameter, $2\frac{5}{8}$ in.; carrier's load, 5 cwt., spaced 60 ft.; capacity, 30 tons an hour; engines, 30 h.p. (petrol marine type); single line (mono cable); length of line, about 40 kilo.; total rise from Itea was 1,880 ft. above the sea, though in one place the maximum height was 2,930 ft.

Defences.

12. The actual details of the defence work in Salonika differ but little from those in the western theatre of war.

The front lines of defence were practically continuous on the Vardar-Doiran and Struma fronts. The section between Doiran and Butkova was not so strongly defended, as the ground was stronger and difficult to approach. Even here, however, the wiring was practically continuous.

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On the "Birdcage" line round the Base itself the line, where occupied, was continuous. In every section occupied there was but little depth. There were practically few reserves and the principle of defence involved was to hang on to the end on a fixed line. Everywhere, however, there were rear lines of defence, constructed on the same lines as the front line, on which troops could fall back. From the Vardar to Doiran there were two or three of these in some places, one or two in others, all inter-communicating.

Besides the front-line systems and the Birdcage there was a retired line running from the Vardar at Vardino through Janes, Kurkit and Vurlan to Lahana, a distance of nearly forty miles.

This line was commenced in 1917. Originally it was what might be called an embryo line. Wiring and M.G. posts were completed, but the fire-trenches and communications were simply sketched on the ground by digging 18 in. deep.

It looked pretty strong from the air. Later, when the 1918 reverses in France made people nervous, the line was much improved and a lot of work was also done on its communications in the Hill country.

The great difficulty with this retired line work was labour; few troops were available and the major portion of the work was done by civil labour, men, women and children. One or two points are worth special mention.

(1) *Birdcage Line, Stavros Section.* This section was occupied by one Brigade. The line ran over the tops of the hills, which were covered with high, thorny, holly-oak scrub. It was awfully blind and the first thing was to clear and lay a field of fire and make obstacles, then provide communications and finally dig trenches, etc. This is worth mentioning, as it brings out the order of work in such cases. On the flat ground between the hills and the sea, also, a rather special type of work was erected for the infantry defence. The design came from Egypt, where opinions differed about it and, I confess, I was not over fond of it myself.

The general idea was to have company defensive areas, sited about 600 yards apart, giving mutual support by echeloning back the flank platoon works and also providing gorge defence by the same means. My feeling about them was that they would prove to be shell-traps. However, they were never attacked, and this accusation must be taken as "not proven." This type of work was also erected between Langaza Lake and Langavuk.

(2) *Retired Line, Vardino to Lahana.* This was started in 1917, when Roumania broke up, and when we thought we were liable to overwhelming attack.

The first object to be attained was to mark the general positions so that retiring formations could make no mistake as to where they were to stand and fight.

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We did this by siting M.G. emplacements and then running the wire along lightly at first and then more thickly, suitable and well-marked gaps being left for the retiring troops.

After this the infantry line portions were broadly marked with shallow-dug trenches deepened later on.

The method was, I think, sound, as it is essential in a retirement to a given position that at any rate the position shall be clearly marked *on the ground*.

General Remarks on Defence Work.

(*a*) The Engineer must study war from the General Staff standpoint, for he must be able to discuss the situation on common ground with the Staff and bring thereto his technical knowledge to assist in arriving at the right decision.

(*b*) An Engineer must remember the men who have to fight in the works he designs, and always must consider their mentality and *morale* when designing. He should always consult with the infantry involved when designing.

(*c*) It is not the duty of R.E. officers to select positions. That duty belongs to the General Staff. I always made a great point of this. Our work comes in designing works suitable to the position selected. To cite one case. The decision as to whether the British line at Neohori on the Struma was to be east or west of the river depended on whether the Engineers could guarantee safe bridge communications across the stream, which was a torrent. We gave the guarantee and the line went on the east side on much the same ground as that held by the Athenians in B.C. 424.

(*d*) Field Service Regulations, Part I, is a very good book and was not written for fun.

(*e*) A word about defences in a hilly, steep country with very well marked ground. Re-entrants are best defended by machine guns at their apices or from behind a lateral sub-feature of the main spur. Salients can usually be controlled by fire from the flanks, and it is usually better to withdraw the infantry fire positions from their points to, say, half-way back across the spur.

(*f*) Everything should be standardized as much as possible. Timber work for dug-outs, M.G. posts, etc., was made so that it could be loaded in sections on mules to transport it up the mountain paths.

(*g*) The heaviest nature of shell which we had to provide for was 8-in. This, I think, was only on the Doiran front; as a rule, 6-in. was the largest. As the result of various trials we found that the following protection was proof against

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8-in. shell:—12 in. stone bursting layers, 18 in. earth: 24 in. stone cover; 4 ft. 6 in. in all. The best support is a steel "Elephant" shelter, but for large emplacements girders of the same character as those used for Komarion Bridge, as described under Military Bridging, were found useful to carry the weight.

MILITARY BRIDGING.

12A. The most important work of this nature was undertaken in connection with the attacks made across the Struma in September, 1916. The 16th Corps was acting in this case as a sort of strategic flank guard on the East, while the 12th Corps was attacking in conjunction with the French and Serbs at Doiran and Monastir.

There were 11 bridges eventually completed: six for 3-ton lorries, three for 6-in. guns, and caterpillars, and two for light traffic. They all had small beginnings. The first crossings were generally made with rafts. Then trestle bridges were built, and improved later on by piling. The work was all done by the Field Companies with the Divisions.

The river Struma is a difficult one to negotiate, as it has a soft sandy and shifting bed, is liable to flood, and the floods break out new channels. In dry weather it is shallow, and not suitable for pontoons, although there was one pontoon bridge in the Neohori Gorge.

When piling, it was necessary to drive the piles a minimum of 16 ft. into the river-bed. The piles were usually 9 in. diameter. The average width of river and approaches was about 100 yards.

In every case when a bridge was completed a wire rope ferry was installed above the bridge as a "stand-by" for use in time of flood. It will suffice, I think, to mention two bridges only particularly.

(a) *Komarion Bridge.*—Built by the 500th Field Company, R.E.

Piers, 9-in. by 9-in. piling, driven 20 ft.; Road girders, 20 ft. long; Top boom, 6 in. by 6 in.; Bottom boom, 6 in. by 6 in.; Stanchion, 6 in. by 3 in.; Web cover, 18 or 19 gauge, sheet iron web, 26 in. deep (*i.e.*, width of sheet iron plates). These girders were tested with a 14-ton concentrated load moving, and gave a deflection of $\frac{1}{16}$ of an inch.

(b) *Neohori (Hall's) Bridge.*—Built by 17th Field Company, R.E., 27th Division. Length 414 ft. (23 spars of 18 ft.). Each pier consisted of four 9-in. by 9-in. piles, 18 ft. long, driven 8 in. into the shingle. Water 10 ft. 6 in. deep, very strong stream. Each span was carried on four wooden girders, each 3 ft. deep. Top boom, 12 in. by 6 in.; Bottom boom, 6 in. by 6 in.; Web, 1-in. planking; Decking, 12 in. by 6 in. Roadway, 10 ft. wide, with a footpath bracketed out on the outside.

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As the main line of resistance of the 16th Corps in case of serious attack was on the West side of the river, all the necessary preparations were made for demolishing the bridges with explosives at short notice. The demolition gear was kept ready connected up in bomb-proof dug-outs near the bridge sites.

In this connection it is interesting to note that when the Bulgars retired, they destroyed their bridges by gun-fire. The demolition was very complete above water, but the piles were found intact and capable of re-use below water-level.

Water Supply.

13. Macedonia is, except in the alluvial plains, a very well watered country. On the Doiran front we were never short of water and could always get it by gravity from springs in the hillsides. The work therefore only consisted in the protection of the sources, piping and storing.

In the Base area on the plain, however, things were somewhat different. The ancient supplies for Salonika town came from the Hortiack and Urenzik Aqueducts.

The Hortiack aqueduct was a Roman work. It was a simple trench, 1 ft. by 2 ft., on the level, and 8 in. by 1 ft. 6 in. on the grades. It ran on a surface grade and was the most wonderful piece of grading I have ever seen. The supply was 16–20,000 gallons per hour, or about 240,000 gallons *per diem*, sufficient for about 8,000 animals and 11,000 men.

The above, however, was not sufficient, and recourse had to be made to well boring to provide the additional water required for hospitals, base camps, etc., etc., in places which the aqueduct did not serve.

The wells were pipe-bores, 6 in., 8 in. and 10 in. diameter. The average number of feet in depth was 300. The deepest was 680 ft. Average cost, £360. In all, 125 wells were sunk.

The wells were drilled by American oil drilling machines operated by a special civil staff under Mr. Hunter. Engines, 7-8 h.p.

The system was by "percussion," and was generally suitable, but in heavy soils the "rotary flush" system is better. Deep-well pumps were used in the bore-holes. These varied from 700 to 2,500 gallons per hour capacity. Of the 125 wells sunk, only 17 were unproductive. Some details as to water rations and consumption may be useful.

Daily Water Rations.—Hospitals—14 gallons per head, summer; four in winter. Camps—Five gallons per man, ten gallons per animal. Pipes—The largest pipe used was 4-in.

A Bakery for 60,000 lbs. of bread per diem required 4,700 gallons per day.

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The total number of gallons pumped per hour from all the Base wells was 9,000 gallons. All water was chlorinated to purify it. In large units this took place in the storage tanks. Hospital tea made of chlorinated water was the most poisonous drink imaginable !

MISCELLANEOUS.

14. Besides the work that has been alluded to above, there were many other services which the R.E. were called upon to carry out, such as :—(1) Veterinary Hospitals ; (2) Rest Houses ; (3) Officers' Clubs ; (4) Soldier's Clubs ; (5) Theatres ; (6) Workshops, etc.

(1) *Veterinary Hospitals and Remounts.*—A large amount of work was entailed. The salient points that were disclosed were :—

(i) Usefulness of wind screens when complete cover was impossible ; (ii) The fact that animals did quite well without overhead cover ; (iii) Dry standings are essential.

2. *Rest Houses at Railheads.*—In the 12th Corps we had two. One at Janes and one at Snevce. Both had cubicle accommodation and baths. We made nice teak furniture for them, each had a good cook, good food, and in each you could get a bottle of champagne in emergency.

3. *Officers' Clubs.*—There was a big one at the Base. I never saw it, but I believe it was good.

4. *Soldiers' Clubs.*—I only know of one at the Base, but we provided facilities up country in connection with the Y.M.C.A.

5. *Theatres.*—We made rather a feature of these. The first built was at Kopriva, I think by the 16th Corps ; we had three in the 12th Corps area ultimately, at Janes, Rathes and Kalinova. I never saw the latter, but the first two were built of brick, with dressing-rooms, stage, etc., etc. The Janes Theatre was lighted with electric light, from a lorry set, and had hot-water heating. It held 500 people who had seats provided, and a bar. In our theatres the slope of the ground was used to get super-elevation for the seating.

6. *Workshops, etc.*—Includes all the Base workshops, stores, bakeries, etc., etc., for R.E., Ordnance, and R.A.S.C., besides railway buildings. In addition, a large amount of brick-making and lime-burning was done. It must here be stated that Salonika, except for raw materials, was at the end largely self-supporting ; we even repaired boots and made soap. Our timber latterly came from the East, when teak and mahogany were much easier to get hold of than common deal.

7. As regards actual construction of the buildings, methods differed very largely. Wood and corrugated iron were principally used ; brick also, but sparingly. Very good buildings were produced

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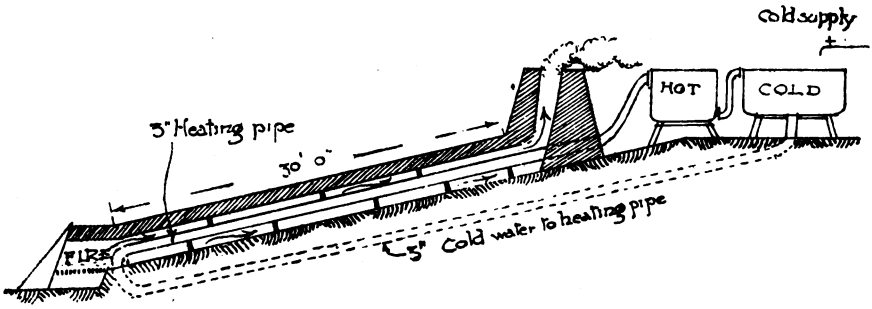
out of wattle and daub, finished smooth inside and rough-cast outside. The frame-work was of squared timber, the walling of scrap brushwood. These houses were cool in summer and warm in winter —they were quite nice to look at and very cheap. Roofs were of corrugated iron, and, for summer use, this should be covered with matting panels.

8. Bathing in winter in Macedonia was not all a joy, as it was so cold, and hot water was, therefore, in great request. The following sketch shows a very simple method of getting plenty of hot water in the field.



Chimney flue to be "Baffled." Ball cock on cold supply. There may be as many returns of the heating pipe inside the flue as desired. The apparatus is really a field water-tube boiler, and is extraordinarily effective.

9. Very good cook-house, latrine and bath-house floors were made with well rammed road metal covered with 1 in. of cement rendering. They were quite good enough to last "for the duration."

The Life of the R.E. Officer.

15. This lecture would not be complete without some reference to this subject. In dealing with it I shall refer only to the most important class of R.E. officer, namely the subaltern. To narrow it down further we will discuss the Field Company subaltern, as his life, I think, was the most exciting.

The Field Company subaltern or Section Commander is a man whose life in war has many sides. To begin with, he must be a good domestic organizer and be an adept in getting food and house-room for his Section and himself. His first care is the well-being of his 50 men, in respect of their health, clothes, food and water, recreation and bathing. It's up to him to see that his men don't get killed for nothing, and that the routes by which he takes them to work are reasonably safe. In fact, he must be their father and their mother. If he is, they will see him through anything he is likely to run up against—in this world, anyhow.

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Besides his men, he has his horses to see to, and his wagons with their contents. His animals' food, water and grooming require his attention if the animals are to be fit. Harness also must not be forgotten, for dirty, hard, harness means galling and inefficiency. A smart turn-out means a good one, with good men who have respect for themselves and their " push."

As regards vehicles, they require constant care, care in keeping them and also keeping them in good order, and their contents require more care still. If you don't look out for the latter, someone else will. A really good subaltern generally has a lot of surplus gear before he has gone far. Where he gets it from, the angel that looks after good subalterns alone knows. However, take care not to overload animals in your anxiety to have lots of stores.

Now for the Engineer work, the most amusing job of all. It covers :—

(1) Reconaissance by day and night. A rather hectic entertainment, sometimes requiring good nerves or better still, no nerves.

(2) Then the work itself—clearly defined to all by word of mouth or on paper by sketches. It must be carefully thought out and laid out, well ahead of the arrival of the working parties, who must be carefully shepherded to the site or they will get lost.

The procuring of working parties is not really the subaltern's work at all, but a persuasive young man can do a great deal in this direction, by means of *quid pro quo* " deals." Carrying parties for stores are also a source of trial for the young R.E. officer. Their facility for getting lost, and their almost incorrigible habit of losing their loads, which are usually heavy, have both to be combated ; not by oaths, but preferably by cajolement and friendship with their commander. Careful bundling of stores in loads of suitable weight for a man to carry is a great help. Preparation of stores and organization of work from day to day give much food for thought. You must have the right stores from night to night and not too many for the carrying parties to tackle.

You have to ask for the carrying parties, and if you ask for too few it's your funeral. Always ask for double what you want (if you expect to get only half your demand). As the work goes on, make reports and sketches of what you are doing, so that if you get shot someone else will carry on comfortably—write very legibly. One last point as to the work. You will have to decide whether it must be carried out by day or night. You will then have to study your enemy's little ways and may run some risk in so doing. Men don't work well if they are suffering heavy casualties and you lose men and gain little by working under too adverse circumstances, unless time is an important factor in the operation. I have given a rough idea of the way a subaltern should tackle his work ; may I say a word about his own conduct ? My advice is—keep smiling

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and keep on at it. It pays all the time. Be prepared to undertake anything with a light heart. Trust your men, lead them and show them you know how. Above all, know everyone from Corps Commanders down, they don't bite subalterns. Drink with anyone, be friends with everyone, don't be a critic, but be helpful in every way you can. Remember this, that the milk of human kindness is more valuable when we all stand in the presence of Death, than at any other time, and that is all there is to be said.

Moral.

16. I suppose no story has ever been written from which there is no moral to be drawn, no lesson to be learned. The lessons I learned in Salonika were as follows :—

(1) That the Military Engineer must learn not to depend on specialists. Out there every R.E. officer pretty well had his turn at everything, and Field Company officers had to build defences, piers for ships and hospitals, find water, lay railways, make roads and in fact, do anything that turned up. There is a place for specialists in big wars, but they are scarce in a side-show.

(2) An Engineer must have courage and imagination. He must be able to look ahead and see in his mind what is coming, strategically and tactically, and be ready. An engineer without imagination is like an " appreciation of a situation " without a " definite proposal for action " as the text-books used to say, which has been compared to a " horse without legs." Courage and a smiling face are necessary to carry the Engineer through the vicissitudes of health, climate and adverse military situations.

(3) In a rough country the engineer that counts is the one who has learnt the arts of observation and quick decision. In civil life men are liable from their environment to observe only one class of things. The soldier engineer must be a close observer of nature and of men, and must cultivate this art continuously. He must go through life with his eyes open and his mouth shut (for choice). By this I do not mean that he must not give his opinion. Far from it. He must not think and talk engineering continually, but must think in concert with the general Staff and then give them his opinion, when it is wanted, tempered by his technical knowledge. If he can then persuade the higher powers that his views are theirs, his path will be a smooth one. Before all things he must remember that he exists for the good of the Army, and not be obsessed with the idea that the Army exists to give him employment.

(4) Any man with engineering qualifications takes a very short time to learn the military application thereof. In the Salonika Army there were very few regular engineer officers. In the Division in which I served as C.R.E., the most I ever had were five, if I remem-

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ber aright. There were only two regular pre-War units of R.E. in the Army, the 17th and 38th Field Companies, the former in the 28th, and the latter in the 27th Division. In the 12th Corps there were never more than eight regular officers at one time. All the R.E. units were Territorial or of the New Army. As far as I know, they never failed. They certainly never failed me in anything. The thing that astonished me most, was the celerity with which these citizen Sappers imbibed the traditions and methods of the pre-War R.E. They had just the same pride and affection for the Corps and its traditions as any of the rest of us.

The Salonika Army.—I must say a word about the Salonika Army as a whole, before I close. In some respects it was a most remarkable force. It served continuously for three years in a most inhospitable and unhealthy country. It constructed many miles of defences, fought continuously from day to day, in the same way as we fought in a " quiet " sector of the line in France, and, in addition, fought several severe actions incurring heavy loss. It practically never got any leave. There were no *estaminets* or relaxations of any sort—no theatres or kinemas until just at the end.

It suffered desperately from disease, and disease of a most depressing and enervating nature and, moreover, one which will last most of its victims for the rest of their lives.

In spite of all this the *morale* of the Army never deteriorated, its industry never flagged, its discipline was exemplary, its gallantry unquestioned. In the end, when the final phase was opening, the sick swarmed out of the hospitals to join the ranks, so strong was their desire not to miss the fun. It was an army, which its distinguished Chief has said he was proud to have commanded, and with which any man may be proud to have served ; even if its activities have, by some, been considered to have been a side-show and a joy ride.

In conclusion, Gentlemen, the future rests with you. Never forget that it is only by maintaining the spirit of comradeship, engendered during the war, between the civil and military branches of the profession, that you will, in the time to come, be able to take the place which it is your duty to fill in the Army of the Empire.

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THE FORTRESS OF ANTWERP

By BRIG.-GENERAL J. E. EDMONDS, C.B., C.M.G.

BY the fall of Antwerp in October, 1914, the faith of the public in permanent fortifications was much shaken, if not entirely lost. No attention was paid to the patent facts that the Belgian field army was far too small to have withstood the first advance of the German legions in the open, and that it must have been defeated, have surrendered, or retreated into France in August, 1914, had not the defences of Antwerp been ready to receive it—thereby incidentally keeping the German observation corps, the equivalent of some six divisions—from the battle of the Marne. Now that Lieutenant-General Deguise, the "Commandant of the fortified position of Antwerp," from 8th September to 10th October, 1914, has published his account of the defence in *La Défense de la Position fortifiée d'Anvers en* 1914 (20 *août*—10 *octobre*),* our wonder is, not that the siege was so short, but that resistance continued so long.

In one respect, in particular, the book is deserving of attention by other than soldiers: it reveals authoritatively, supported by official documents, what has been the cause of so many military disasters:—neglect by politicians of the advice given by their responsible military advisers, and economies effected for electioneering purposes at the expense of the vital interests of a country. Most of us knew that the fortifications of Antwerp were out of date and too close to the town, and that the so-called "shell-proofs" had not the cover over them, found necessary by experiment in France, Russia and Germany, sufficient to resist even 6-in. shells; but it is with almost a shock we read that the great fortress, the national refuge in time of danger, had no smokeless powder for its guns, and was not provided with a single high-explosive shell. Further, that even the improvements authorized on 30th March, 1906, had not all been carried out, *e.g.*, the concrete aprons round the gun emplacements had not been constructed, and there was no telephone system. The expenditure required for these and other urgent matters had been "deferred for political reasons." In peace-time the Minister of War silenced military representations by declaring—"I am responsible to the people"; on the approach of the Germans, as

* Paris: Berger-Levrault, price 25 francs.

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he stepped into his motor-car to make off, he said to General Deguise, "You are responsible for the defence."

After an historical survey of the defences of Antwerp, there follow in General Deguise's book chapters on the "Powers of resistance of the forts, redoubts, and *points d'appui* of the principal line of defence," and "The situation in August, 1914, as regards guns and ammunition;" "The methods of fire," an artillery appreciation; "The Garrison," etc., and a second part relates the defence against the Germans. Taken in combination with the official account, "*Antwerpen*, 1914,"* the book presents a very complete story of the siege. The Belgian account gives us the state of the forts, etc., before the bombardment; the German provides the number of guns used and rounds fired, with the targets, and finally the state of the defences at the capitulation.

The thickness of concrete (plain; ferro-concrete is not mentioned, and there was very little of it) in the shelters was 2·25 to 2·50 metres. The extrados of the concrete arches had 250 kilog. cement per metre cube, the intrados and walls, 170 kilog. The Germans found that the concrete had "faults both in the composition and the laying." The forts, and the redoubts in the intervals between them, made no pretence at concealment; they stood up like green islands from the plain in which Antwerp lies.

As regards the artillery defence, "in August, 1914, the armament was not entirely installed, nor even delivered;" the guns were entirely inside the forts, in cupolas or casements; they were entirely outranged (extreme range, 8,400 yards) by the German guns; there was only three-fifths of a 6-in. gun per kilometre of front; and the flanking guns were old smooth bores, "dating from 1862." "There were only two machine-guns per work."

As regards observation of fire, although a permanent communication system was lacking, all the telephone cable available was carried off by the field army, and electric bell wire was used in its place; the observers had to provide their own telescopes and field glasses: "many possessed only opera-glasses."

The war garrison consisted entirely of men of the older classes—"who had left the Army five years, even thirteen years before; they had only received altogether insufficient refreshing courses, and remembered nothing of what they had learnt during their short period with the colours in peace time."

The German account shows that 590 shells from 42-cm. (say 16-in.) howitzers, 2,130 from 30·5 cm. (say 12-in.), and 11,800 from 21-cm. (say 8-in.) were fired against Antwerp, the 21-cm. mostly against the works in the intervals between the forts. These intervals, it may be noticed, were defended by field-works, but owing to the high

* Issued by the *Reichsarchiv* (Berlin: Stalling, 19 marks).

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water level, the trenches were shallow, and " there were no shelters, not even against shrapnel bullets."

Tables in *Antwerpen* show exactly what shells were fired against each fort, with the range. Thus Wavre-St. Catherine, the first attacked, received 171 16-in. from 10,000 yards, and 327 12-in. from 8,500 yards: both its cupolas for two 6-in. guns were destroyed. Four photographs show the other damage done: the left half of the fort appears to be rubbish heap, and the roof of the shell-proof barracks was simply cut through in five places and exposed in section. It is worthy of note that the small redoubts were not rendered untenable by artillery fire. Thus, though Fort Wavre-St. Catherine was evacuated on the 28th September, Dorpveld, the redoubt next to it, held out until the 2nd October, and then was taken only by assault, in which the attackers placed charges on the roofs of the casemates in which the Belgians still held out. Salvation from heavy mortars lies no doubt in small works, interspersed with dummy defences, as the Germans knew and had adopted in their *Feste*. It will be recalled that Lötzen, the Prussian fortress in the Masurian district, though invested and bombarded by the Russians, was not captured.

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TRAINING OFFICERS IN THE CORPS OF ENGINEERS, U.S. ARMY.

Extract from the Annual Report, for 1920–21, *of the Chief of Engineers, U.S.A., Maj.-Gen. Lansing H. Beach.*

(Reprinted from *Engineering News-Record* of 19th January, 1922).

ENGINEER officers of the Regular Army enter the Service from two principal sources, military organizations and civil life. Officers from the first source include those commissioned from United States Military Academy, from the Regular Army, and from units of the Reserve Officers' Training Corps. Those from the second source have had little or no military training and usually enter the Service within a short time after being graduated from civil technical institutions.

The difference in preparation prior to appointment in the Army involves some variations in the training of these officers during their early years. Those entering the Army with previous military experience usually require special stress on technical subjects in the formative period of their commissioned Service, and those entering without previous military experience require special stress on subjects peculiar to the military profession, such as military art, military administration, military law, etc.

On his initial entry into the Corps of Engineers the officer in the normal case is sent to the Engineer School at Camp A. A. Humphreys, Va., to pursue the basic course. This course, during the last year of five months' duration, comprises only elementary subjects such as administration, guard duty, law, military courtesy, military hygiene, hippology, field-service regulations, infantry and cavalry drill, minor tactics, and troop leading, to include the company nomenclature, care and use of engineer equipment, map reproduction and photography, elementary bridges, railroads, etc. . . . The course was followed by actual service with troops.

While the basic course is adjusted as fully as possible to the varying needs of the student officers drawn from the several sources, it is evident that on its completion the fundamental differences in the early training of these officers will not have been compensated. Those from the Military Academy and those from the best private military schools will usually be stronger on military subjects and weaker on technical subjects than those drawn from civil technical schools. These differences are taken into account in making the assignments for the six or seven years following the completion of the basic course.

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The next step in school training is covered by the company commanders' course at the Engineer School and the civil engineering course conducted under the supervision of the Engineer School at high-grade civil technical institutions. All officers take the first of these two courses, but those who hold degrees from civil technical institutions of recognized excellence are not required to pursue the civil engineering course. They may, however, attend special courses in lieu thereof, such courses being designed to supplement their previous training.

Either before or after pursuing the company commander's course, officers commissioned from military sources are sent to civil institutions for one year of instruction in those technical subjects which either are not taught at West Point or which are given there in a very elementary form, but which are needed by the engineer officer in the discharge of his professional duties.

It is proposed that the policy adopted for this year's civil engineering course be continued, that is, that of sending the students to civil institutions of recognized high merit. This policy is not new. Since 1910 officers of the Corps of Engineers in small numbers have been sent to civil technical schools for instruction. Other government departments and arms of the service, notably the Navy, have committed themselves to it as a fixed policy. There are many good reasons for this policy, and the result of this year's work fully demonstrates its highly beneficial effects.

Among these reasons may be cited the psychological effect on the officer student and on the general public. In the past the military and the civil have been most distinct, both in training and method of life. This has led to mutual distrust, a pretended fear of militarism, which is not only bad for the service but ruinous to the country at large. Entirely due to ignorance of our former method of instructing our officers in technical subjects, civilian engineers have somewhat the same misgiving as to the professional attainments of army engineers. Such criticism is at this time quite prevalent in connection with the campaign for the creation of a department of public works. It is without foundation in fact and overlooks the achievements of army engineers which exist in public buildings and monuments, such as the Congressional Library and the Washington Monument; river and harbour improvements such as the Panama Canal, and the vast and complicated engineer undertakings in France, all of which were under the supervision of army engineers. Such doubts will disappear, and no grounds whatever will exist for mistrust when the engineer in civil life realizes that his colleague in the army is a product of the same, an equal, or a better civil institution than himself. The reciprocal knowledge of the technical capacity of civil and military engineers will be established for all time by contact formed at these civilian institutions.

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Another reason for the use of civilian institution for the civil engineering course is that by eliminating this course from the Engineer School proper the use as instructors of many high ranking officers may be avoided and much overhead expense may be thus eliminated. This point is particularly important at this time when the demand for economy is so great. It is to be noted, if officers are to be developed as instructors of efficiency equal to those in civil institutions, some of them must devote their entire life to pedagogical work, and even then they may not reach so high a plane of teaching as those instructors in the best civilian schools. Still another reason for using civilian institutions for the civil engineering course is that better equipment can be obtained at less expense in the better civil institutions.

A consideration of the foregoing appears to show conclusively that the policy for instruction in technical subjects is sound. Officers of the Corps of Engineers should attend civil schools which possess ample equipment, a corps of selected instructors, with efficient courses and methods of instruction. Further, through the intimacy of college life mutual relations of respect and good-will can be established and maintained between the professional military engineer and his colleague who remains in civil life. Such relations undoubtedly benefit the administration of government affairs, not only in time of war but in time of peace.

On completion of those two courses the officer spends two years in practical work in connection with river and harbour improvements or fortification projects and is then again detailed with troops for a period of two years. In addition to the practical work which can be furnished by the corps itself, officers are detailed to various industrial concerns, such as railroads, large construction companies, etc.

The programme above indicated covers the first six or seven years of the officer's commissioned service and during this period of service as a lieutenant, and, perhaps captain, aside from instruction received by school courses, he receives training in administrative and executive work as an assistant in the office of the Chief of Engineers or as an assistant to Army, Corps, or department engineers, or he may receive training in supply work as an assistant or a principal in charge of an engineer depôt. He acquires experiences in construction as a district engineer or as an assistant to a district engineer on river and harbour and fortification work.

On or shortly prior to promotion to the grade of field officer he may take the field officers' course of approximately six months at the Engineer School, Camp A. A. Humphreys. This course endeavours to acquaint him with the duties of a field officer of engineers and of a staff officer for the Engineer Service. It stresses the relations of engineers with the staff and other troops. On completion of this course the officer is either sent to the school of the line or is returned to engineer duty.

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PROFESSIONAL NOTE.

CLEANING OF HOT WATER BOILERS.

In most districts it is necessary periodically to clean all Hot Water Boilers on account of the scale of sediment deposited from the water and which not only greatly reduces the efficiency, but, if allowed to accumulate, becomes a source of danger from the probable burning of the boiler-plate.

This deposit is greatest in the parts where the furnace heat is most intense, and often where it is inaccessible without removing the boiler. Especially is this the case with "Boot" and other small domestic boilers.

In order to reduce the expense and labour thus entailed, the practicability of cleaning by chemical means has been considered, and experiments carried out with satisfactory results.

When the deposit is mainly due to "temporary" hardness of the water, *i.e.*, consists largely of calcium carbonate, it should readily dissolve in hydrochloric acid.

Small quantities of insoluble deposits derived from slight "permanent" hardness of the water would probably disintegrate as the calcium carbonate goes into solution, and could be removed in the form of sludge.

Should the deposit be mainly due to "permanent" hardness, this method of cleaning would not be very effective.

Hydrochloric Acid of commercial quality is used diluted with water, the strength varying with the thickness of the deposit from 2½ per cent. (2½ pints commercial acid made up with water to 4 gallons of liquid), to 8 per cent. (2 pints commercial acid made up to 1 gallon). A stronger liquid should not be used.

The operation is as follows :—

(1) The system is drained. (Provision is usually made for this by means of a plug on the return pipe).

(2) A sufficient quantity of the liquid to fill the boiler is introduced at any convenient point above the boiler, or the boiler may be filled through a short length of hose-pipe connected to the drain outlet.

Violent gassing ensues (due to the liberation of carbonic acid gas), and gradually subsides, generally ceasing within about two hours. The cessation may indicate either that the whole of the deposit is dissolved or that the acid has expended itself.

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(3) After standing about two hours, the boiler is drained. If the acid is spent and inspection of the boiler shows that the scale has not been removed, fresh acid is added. The drained-off liquid can be easily tested for acidity by the addition of a small quantity of washing soda. If spent, there should be no effervescence.

So long as gassing occurs on the addition of fresh acid the liquid drained off will have a milky appearance, absence of this denotes that the solution of scale is completed.

(4) Boiler is drained and cold water supply turned on for a short time to thoroughly wash out any sludge. It is then again emptied.

(5) Boiler filled with 5 per cent. solution of common washing soda to neutralize any possible trace of acid. After standing for a quarter of an hour this is drained off and the boiler re-connected and filled ready for use.

A rough estimate of the quantity of acid which will be required can be obtained if the thickness of the scale is known, by allowing 2½ lbs. of the undiluted commercial acid for every pound of scale to be removed. The cost of acid is about 20/- per cwt.

The risk of corrosion of the boiler plates is very small if the application of acid is not prolonged after removal of scale, and the chances of damage are probably less than if cleaning were effected by chipping.

Galvanized hot-water cylinders must not be treated in this manner, as zinc is readily attacked by the acid.

It must not, in any case, be used for steam boilers without the sanction of the responsible Insurance Company.

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MEMOIR.

COLONEL W. D. LINDLEY.

COLONEL WALDEMAR DELMAR LINDLEY was born in 1853 at Flensburg in Denmark, where his father was then engaged in railway construction. Lindley was educated at Eton and the "Shop" and obtained his commission in the Royal Engineers in 1873. Of his total service just half was spent abroad, chiefly in India, where he joined the Madras Sappers in 1877. With them he accompanied the Indian contingent to the Mediterranean in 1878, serving in Malta and Cyprus. He also went through the Afghan War of 1878 to 1880, being *inter alia* engaged in the Bazar Valley Expedition, and in the operations against Khugianis and Hissarak Ghilzair. "Always cool and collected under fire" is the recollection of a comrade. It was characteristic of Lindley that on returning from the first phase of this war he insisted, although his health had suffered severely, on going to the second phase, for which a junior had in the first instance been detailed. Lindley also went from India with the Egyptian Expedition of 1882, during which he took part in the celebrated night march to Tel-el-Kebir. Later, he was at Suakin during the Soudan Expedition of 1885. He completed his Indian service (Madras S. and M. and P.W.D.) in 1890, afterwards serving at home and in Hong Kong. Finally he was C.R.E. Jersey for three years.

Colonel Lindley did not marry. He retired in 1905 and lived very quietly near Dover, spending most winters abroad, often in Algiers. For the last few years of his life he was an invalid. He died at Torquay on the 21st November, 1921, and was laid to rest in Elmstone churchyard, in his brother's parish near Canterbury.

Never of very strong constitution, fever in Cyprus, and strenuous work on roads and demolition in the Khyber, followed by active service in Egypt and a prolonged tour in India, undermined his health to an extent from which he never recovered. This, coupled with his extreme reserve, prevented him from becoming widely known in the Corps; but those who served with him remember "Father

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William," as he was affectionately called, as a hard and thorough worker, a first-rate rider, and a gentleman in the best sense of the word.

His brother writes that at Eton Waldemar " first became fascinated with that peculiar love of his for boats " which remained a marked feature of his character. Indeed, it was on the sea that his rare intimacies were chiefly formed. At sea he seemed to cast off his reserve, revealing the real charm of his personality. The writer sailed often with him in the brave days of the schooner *Violet*; and again, of recent years until the war, in many cruises to Scotland, Orkney, Shetland, the West of Ireland, and other remote waters. Lindley was the ideal companion. An expert yacht hand, with infallible instinct for doing the right thing, not only was he invaluable on board, but nothing could damp his spirits or disturb his equanimity. Even when under way for a week or more in a small vessel, no exigencies of weather or food annoyed him. He loved the sea and, aided by a strong dry sense of humour, found enjoyment in everything that came.

A cruising friend of long ago writes, " At the S.M.E. Lindley was distinguished as a first-rate oar and an intrepid sailor. I have delightful recollections of the strength and gentleness, the fiery spirit under perfect control, and the benevolent smile of dear old ' Father William.' "

These words remained true of him, and well recall the picture treasured in memory by his friends.

M. A. C.

PRESERVATION OF COMPANY WAR DIARIES AND WAR RECORDS, AND COPIES OF PRIVATE DIARIES.

MANY officers, no doubt, kept diaries during the War, and preserved various documents and maps that they used.

To ensure that these unique documents do not disappear in the course of time, it seems desirable that it should be known that there are several courses open to officers who possess such papers, namely, to deposit them :—

(1) With the Institution of Royal Engineers ; or

(2) In the British Museum ; or

(3) With the Historical Section (Military Branch) ; or

(4) In the Imperial War Museum Library.

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It is hoped that all who are still in possession of original records of any sort will provide in some way or other for their permanent custody.

If these records are deposited with the Military Branch of the Historical Section, they are at once filed in their proper place among all the other War Records of which that Branch is the custodian. Further, as the War Diaries of all formations and units are stored in the same building, the completion of these records, in even a small particular, will mean that a more connected and detailed story of the period under review can be written when the time comes. There is a reading room in the building where properly accredited officers can read and work; so whatever is deposited is always available for study and research.

A copy of every privately printed book, giving the War record of any unit should, in any case, be deposited at the British Museum; and it is hoped that another copy will be presented to the Library of the Historical Section, so that it will be always available to amplify the existing documents.

J. E. EDMONDS,
Brig.-General, late R.E.

Historical Section (Military Branch),
Committee of Imperial Defence,
2, Cavendish Square, W. 1.

March, 1922.

REVIEWS.

MILITARY ENGINEERING (PROVISIONAL). (VOL. III). BRIDGING, 1921. (Price, 3/6 Nett).

By J. W. Landon, M.A. (Cantab).

On opening this volume the first thing which strikes one is the price; not because of its prominence on the title-page, but on account of the smallness of the amount. It is, of course, due to the fact that this is an official publication. Considering the quantity and quality of the information the volume contains, it must be by far the cheapest engineering book produced since the War. The book is issued by command of the Army Council for the guidance of all concerned, and the issue is provisional, pending the introduction of a new pontoon equipment to carry heavier loads. A simplified pontoon drill for light bridge is intro-

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duced which has stood the practical test of the war. The steel-girder bridges described have been selected from the many used in the war, as those most suitable for retention for training purposes. This information is extracted from the Preface. Turning to the contents, one notes a considerable change from the *Military Engineering, Vol. III. B*, issued before the War, the chief difference being the prominence of heavy bridging, including steel-girder bridges. The latter is an entirely new feature. Comparing the two volumes, one can realize easily the enormous difference in the magnitude of the bridging problem as presented in the Great War, and the bridging problem of previous wars. Indirectly, one also sees how successfully this problem was solved. The foundations laid down in the pre-War training were sound and had only to be extended. The chief difference was in the magnitude of the loads to be handled; which, instead of being a few tons, rose to a launching weight of over fifty tons.

Part I of the book deals with Military Considerations, Reconnaissance, and Bridge Loads. The chapter on Reconnaissance is very full and thorough, and bears the stamp of actual experience. Complete particulars of overall dimensions and weights of all vehicles likely to be met with are tabulated. In one table the various bridge loads are conveniently grouped as "Light loads," "Medium loads," "Heavy loads," "Tank loads," and the maximum axle load and the equivalent uniformly distributed dead load for each of these groups is given for different spans. These are extremely valuable for rapidly designing improvised bridges. In the field, the most troublesome calculation is the estimation of the maximum bending moment and shearing force which the bridge has to carry. Given these, the necessary calculations are relatively straightforward and simple, and can be made rapidly.

Part II deals with pontooning, and is to some extent provisional as noted before.

Part III treats of "Field Bridges of Various Types," *i.e.*, bridges which are largely designed and constructed in the field from whatever material is available. Accessories required for bridging operations occupy a chapter which is full of useful information, dealing as it does with cordage, ropes, chains, etc., and the various machines used for raising and moving heavy loads.

Another chapter is devoted to "Suspension Bridges and Aerial Ropeways." The latter are dealt with in considerable detail and the standard ropeway which has been introduced, known as the "General Utility Ropeway," is described.

Tension bridges have been omitted from the new volume, presumably owing to the difficulty in making them stiff enough for heavy loads. When constructed with light steel girders for the roadway and steel piers and concrete foundations, this type of bridge may be made entirely satisfactory. In this form, the French made use of Tension Bridges. One good feature of the type is the ease and accuracy with which the stresses may be estimated.

Under the heading "Trestle Piers and Timber Bridges," design and details of construction are dealt with, as well as the strength of various types of joints.

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A new form of pier construction, introduced during the War, is described and illustrated. In this construction the piers are built of skeleton steel cubes, 3 ft. by 3 ft., by 3 ft., and these are braced together every 3 ft. by horizontal timber members fitting between the cubes, and connected to them by coach screws. The cubes themselves are built of lengths of steel angles with steel flats as diagonal bracing. These can be transported in bundles and be bolted together at the site. Each cube will carry 40 tons, provided it is only loaded at the corners. This type of pier is very quickly constructed. The bearing-stress on the timber would appear to be high, if the cubes are fully loaded, but this could easily be reduced by introducing small triangular plates at the corners of the cubes. The plates would distribute the load on the timbers and would also ensure that the cubes were only loaded at the corners. Apart from their military use, these steel cubes appear excellently suitable for building falsework and might profitably be employed by civilian contractors.

Although this volume deals but briefly with strength of materials and design, many useful examples are worked out, showing the calculations necessary in the field. These call for some slight comment in cases where *shear* in timber beams is dealt with. The shear is assumed to be uniformly distributed down the cross-section, whereas actually the maximum shearing stress is $1\frac{1}{2}$ times the mean in beams of rectangular cross-section, and $1\frac{1}{3}$ times the mean in beams of circular cross-section. In one example, the maximum shearing stress along the grain is as high as 326 lbs. per sq. in. and the allowable maximum is stated as 150 lbs. per sq. in.

Abutments and piled piers are next dealt with, and the chapter contains much useful and practical information about pile driving.

Part IV. treats of "Steel Girder Bridges," and is entirely new. The sections dealing with "Organization of Work" are particularly good and deserve a close study by those who are likely to be in charge of this class of work. Success depends to a very large extent on proper organization, and the foreseeing where delays are likely to occur.

A useful account of suitable methods of erection and launching of girders follows. One point of detail calls for criticism. The method adopted in launching the 120-ft. Hopkins Bridge consists in bracing the two girders together and using two independent derricks on the far side of the gap and two independent preventer tackles on the near side; a main hauling tackle and a preventer tackle being attached to each girder. This method, although it has been successful, is undoubtedly unsound and risky. It is impossible to guarantee that all the tackles are worked at the same rate, and if this is not so the load will be unevenly distributed. One tackle may have to take a much greater load than was intended, and there are no ready means of detecting whether this is so or not until failure begins. If, instead of two preventer tackles, a single one is employed, connected by a snatch block to a long wire rope sling, and one end of the sling is attached to each girder, then any inequality of the pulls in the main tackles will show itself by the tail of the bridge moving somewhat obliquely to the centre line of the abutments. This is easily detected and remedied.

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A chapter is devoted to the various types of the Inglis Bridges, the girders of which are built up of steel tubes and specially constructed steel junction boxes. These bridges are remarkable owing to their portability, the novelty of construction, and the truly surprising rate at which they can be erected and launched by a trained party. A bridge of 105-ft. span to carry 35 ton tanks can be erected in a single night.

Hopkins Bridges are next dealt with. These are built up of standard steel sections, bolts being used for the connections instead of rivets. As the heaviest single member weighs only 10½ cwt. they are quite portable. They admit of a large number of erectors being employed simultaneously, but, owing to the time required to make the bolted connections and the method of launching, the time required for construction is long compared with that of the Inglis Bridges.

The text of the book finishes with a chapter describing the Stock Spans up to 60 ft. Full particulars of construction and directions for erection are given.

Though written specially for the instruction of military engineers, any engineer who has to construct improvised bridges, or erect steel bridges, will find much of value and interest in the book. The heavier the type of bridge, the more nearly do civilian practice and military practice approach. The chief difference lies in the amount of labour available, and the absence of consideration of cost from military practice.

The book is in no sense a theoretical text-book, but a book full of sound practice based upon actual experience, and contains a lot of valuable information not usually available in a single volume.

HYDRO-ELECTRIC DEVELOPMENT.

By J. W. MEARES, F.R.A.S., ETC. (London, Sir Isaac Pitman & Sons, Ltd.) (Price, 2s. 6d. net.)

One of Messrs. Pitman's useful series of Technical Primers, this book deals with the general principles of the utilization of the energy of falling water. Commencing with the elementary dynamics of the subject, the probable available flow from a given rainfall and run-off is next considered. The section dealing with map reading and reconnaissance will be familiar ground to all military engineers. Other chapters deal with the lay-out for various conditions of fall and flow, the elementary design of works and miscellaneous application such as combined steam and water-power stations.

The print is good and the book is well indexed: the illustrations, however, are somewhat inadequate, some 15 out of the total of 17 being of the thumb-nail sketch order. The book, however, can be recommended as being a sound survey of the present state of water-power engineering. A large amount of useful data is given with numerous references to standard works.

R. C. B.

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NOTICES OF MAGAZINES.

MILITÄR WOCHENBLATT.

No. 26.—*The German War Office in the War.*—General von Wrisberg's account of the German War Office and its activities during the war appears. He defends the War Minister of the years just before the war (von Einem) for not supporting the demand for three additional Army Corps, for which the General Staff under von Moltke was then pressing, on the ground that to have created them before 1914 would have disorganized the Army. In the memorandum (December, 1912) by the General Staff their formation was advocated in order to give sufficient strength for the offensive in the West, combined with adequate defence in the East. The additional expense was, the General Staff said, nothing compared to what the country would have to bear in case of defeat.

General von Wrisberg adds that, as a matter of fact, the three additional Corps were, numerically, equalized by the Reserve Divisions which were so quickly formed at the beginning of the war, and that von Moltke's predecessor, von Schlieffen, never reckoned with them in his plan of operations. The latter was prepared, if necessary, to give up all ground east of the Vistula, if thereby victory in the west could be assured. The *M.W.B.* says that it was not the lack of three Corps which lost the Marne, but the lack of nerve at G.H.Q.

That the expansion of the German Army was not carried even further than it actually was, is said to have been due to inability to dilute the Officers' Corps. To us this hardly seems a sufficient reason, but the *M.W.B.* attributes the failure to break through at Ypres in 1914 to the inferior quality of the new Divisions which were there first employed. Expansion was nevertheless carried to considerable lengths; for instance, in 1918 there were 2,800 field batteries as against less than 600 in peace time, while heavy batteries increased from 150 to 1,660. In May, 1917, there were 7,030 heavy pieces at the front, of which no less than 1,016 had been captured from the Allies.

It is admitted that at the beginning of the war Germany did not retain nearly enough officers at home, a mistake which every country seems to have made.

General von Wrisberg seems to have been able to leave his post as "Director of the General War Department" fairly frequently, and at one time actually held a command in France. On one of his visits to the Second Army in May, 1918, he noted a serious diminution in discipline. It was this army which failed, on August 8th, before the Fourth British Army.

German Propaganda in the War.—At the outbreak of war there was no organization in existence, and it was not till the Spring of 1915 that propaganda in Germany was undertaken by the Home Office. Six months later efforts were made to get the Foreign Office to take it up abroad, but without much success, as the psychology of the subject was

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always misunderstood, sometimes with ludicrous results. How much better, says the *M.W.B.*, did the Entente work, and how successful it was in " striking the sword from the hand of Michael " !

Who Was to Blame for the War ?—There have recently been published in Germany letters between the ex-Kaiser and Hindenburg on this subject. The latter pointed out to his former master how the confession of guilt forced from the German delegates at Versailles was affecting the whole position of Germany in the world. In reply the ex-Kaiser, after asserting the innocence of Germany and the guilt of her enemies, said, " The true facts can only be made known by means of an international and impartial commission, the establishment of which has been refused by the Entente. For Germany it is a sacred duty to gather together all evidence bearing on the subject, and to publish it to the world, so that the real culprits may be made known."

War Pensions.—In view of the increase in the cost of living in Germany, pensions have to be continually augmented. From 1. 10. 21 a new scale came into force ; the following are some instances of the pensions payable under it :—

Lieutenant	with	15	years'	service	...	...	9,444 Marks
Major	,,	30	,,	,,	...	...	28,455 ,,
Colonel	,,	40	,,	,,	...	...	63,900 ,,
Maj.-General	,,	40	,,	,,	...	...	71,400 ,,

All the above amounts are " per annum " and with the exchange round about 800 Marks to the pound sterling, give some idea of the conditions under which German officers are existing.

No. 27.—*With the Russian Army*, 1914–17. Major-General Sir A. Knox's book is reviewed at length and receives high praise. The *M.W.B.* hopes it will be translated into German so that the public can learn from it what the Bolshevism, with which they trifle so light-heartedly, really is.

Death of General von Beseler.—The victor of Antwerp and of Novo-Georgewski has died, at the age of 71. He was originally in the Pioneers.

The German Trade Flag.—The German Chamber of Commerce in Valparaiso has passed a resolution protesting against any change in the colours under which German merchant ships sail. It points out that in South America such a change would be a death-blow to German trade, since the old black-white-red was always associated with honesty and enterprise.

No. 28.—*Political and Military Review of* 1921. The German 100,000 strong Army has solidified as well as could be expected, and has suffered no severe shocks during the year. The prohibition of any political action by or towards the Army has had an excellent effect on it. Recruiting is not so brisk as might be hoped, and it is not possible to select as high a class of recruit as is desirable. For the present the officer question presents no difficulties, but the *M.W.B.* is anxious about the future and hopes that the old officer families will not hold their children back. Promotion, which can only come through the ranks, will not be so quick as recently, but will probably be better than it was before the war.

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The Inter-Allied Mission of control has continued its, in German eyes, nefarious work. Gen. von Cramon seems especially to dislike it and apparently had a row with one of its members in Munich.

French armaments are also a ground for complaint—and envy. The inclusion of large numbers of coloured troops in the French Army, and the quartering of the greater part of the Air Service on the Eastern Frontier is also noted. Franco-British relations constitute a brighter spot in the political horizon, and it is pointed out how developments of artillery have not only rendered any action of the British fleet against land defences more ineffective than ever, but have also brought large stretches of British coast line within easy range of French land batteries ! England, the *M.W.B.* is careful to point out, is no more inviolable, and hopes the French will turn their attention to the North instead of watching so steadily towards the East.

The Laws of War.—In a recently published French book an account is given of how two Germans were captured by the French on the Chemin des Dames front on the 26th May, 1918 (the day before the German attack).

On being examined by the French, one of the two declared that every preparation had been made for an attack on the morrow ; the other, an officer-aspirant, stated that there was no thought of attack. The same day they were sent back to Corps Headquarters for further examination, and gave the same answers, the officer-aspirant protesting volubly that no attack was contemplated. It was then pointed out to him that, though the laws of war could not compel him to speak, yet he had volunteered information and must be responsible for it. If it turned out false he would be treated as a spy. On this the officer-aspirant was clearly embarrassed, and on further questioning gave full and exact information about the forthcoming attack.

The story is ordinary enough, and the French procedure seems to have been perfectly correct from every point of view, yet Gen. von Winterfeldt seizes upon it as another instance of French cruelty to German prisoners !

No. 29.—The cost to Germany of the pay and allowances of the personnel composing the Inter-allied Mission of Control is causing some comments, and the emoluments of similar ranks are compared in a table, showing that a private soldier in the Mission receives more than a full general in the German Army.

At the same time, complaint is made of the extravagant cost of the French Army of Occupation, in which the proportion of officers to men is as 1 to 25. If this is thought excessive, what must be thought of the British Army ?

Instruction in Sports.—A sports school has been started in Wunsdorf, near Berlin, where not only young officers and N.C.O.s are instructed but there it is intended to send also more senior officers and some staff officers so that commanders may be well advised and assisted in all matters of games and sports.

No. 30.—Contains little of interest.

L. CHENEVIX-TRENCH, *Major, R.E.*

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REVUE MILITAIRE GÉNÉRALE.

November, 1921.

The Revision of the Regulations.—A continuation of the article by "Lucius" embracing the second portion of the 4th period, viz.: the Allied offensive on the Somme, July to November, 1916. Besides the 12 divisions and 700 heavy guns sent by the French, they brought 580 trench-guns; a total force which was quite unexpected by the Germans. The troops for the most part were of very good quality, the infantry newly equipped with automatic rifles and the Vivien-Bessières grenade, and specially trained for attack, besides preserving the advantage of experience gained at Verdun. To face the combined force, the Germans could only dispose of the Second Army (von Bülow), of which one Corps deployed five divisions in front lines to the north of the Somme on a front of 30 kilometres, the other Corps four divisions on a front of 28 kilometres south of the river. Behind these was a first reserve of three divisions, and in rear again a second reserve of one division only, allowing on the average six or seven kilometres of front to each division, far too small a force, and yet the attack was not altogether a surprise for the Germans. Their Air Force, since February, had indicated a probable British attack, but it was not until May that co-operation by the French could be foreseen, and the Second Army was only reinforced in artillery; partly, no doubt, owing to the wastage of Verdun, and partly to Brusilov's offensive of June in Galicia. In spite of the German experience at Verdun, the Allies adopted similar tactics at the Somme, and in addition to attempting to wear down the enemy, also proposed to break through his position, although surprise was out of the question. It was agreed that successive attacks on limited objectives must by degrees wear out the enemy and in the end result in the rupture of his front. Instructions to the troops warned them against unduly pressing local successes which would form dangerous salients, but pointed out that when the organized defences were destroyed the methodical advance could be abandoned for bolder measures. The dash of infantry is not so much weakened by a slow and cautious advance as by the unexpected appearance of obstacles or flanking machine-guns. The artillery preparation need not be slow, but must be thorough, the ensuing infantry attack must be as rapid as possible, and so much the better if it involves surprise.

Here follows a short account of the Battle, which is omitted.

The result of the offensive was to restore the initiative to the Allies, the Germans had to bring troops from Verdun, and when Hindenburg replaced Falkenhayn on 20th August, the German offensive at Verdun was put an end to. The Germans, in two months on the Somme, lost as many men as in six months at Verdun. It is noteworthy that it cost less in killed and wounded to gain ground than to lose it, the French experienced this also at Verdun, and the fact will be confirmed in 1918. However, the Allies could not manage to break through to open warfare, not that the means were insufficient, but the procedure did not admit of such rapidity in the succession of attacks as to prevent the enemy from

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re-establishing the situation by preparing a new position further back. Moreover, at least two favourable opportunities were lost owing to stereotyped methods. Ludendorff has now admitted that following on Verdun the Germans were always on the verge of a catastrophe on the Somme.

Lessons of the Offensive.—Surprise was not obtainable, except perhaps south of the Somme, where the Germans did not expect such a powerful attack on the part of the French. At the Somme, as at Verdun, the increasing weight of artillery in the attack, and the development of aviation were marked features. On 3rd September the artillery averaged one field-gun per 38 metres, one heavy gun per 20, and one trench-piece per 22 metres, which appears to be about the maximum density possible. The value of mastery in the air was proved. The employment of gas-shell became general and gave good results, not only in neutralizing the enemy artillery during an attack, but also in reducing the length of the artillery preparation. At the Somme the British introduced tanks on 15th September, unfortunately in too few numbers, and before the infantry had learnt to co-operate with them, with the result that German attention was too early directed towards means for combating them. In the attack the procedure advocated by the Instructions of January, 1916, was not quite satisfactory, infantry formations were still too dense, and orders were not always complied with as quickly as they should have been. A note of 27th August drew attention to the increased offensive power of infantry, due to the issue of automatic rifles, the new hand grenade, and the 37-mm. gun, which should enable successes to be exploited without delay, but the action proposed was still too hesitating, the principle of maintaining the continuity of the general lines, and not advancing beyond the limits laid down by the formation commander who controlled the supporting artillery (generally the Division Commander), was still recommended. Commanders of Armies, indeed, directed more prompt following up of successes, and pointed out that the artillery could not do everything ; that the infantry were there to fight and not only to occupy ground when it had been absolutely swept clean by the guns, and that they must take their fair share in ousting the enemy from his defences. It is evident that the infantry had accepted a little too willingly the secondary rôle which had been allotted to it in the attack, but common-sense will admit that once the infantry is ordered to advance it must assume its own initiative. Method and deliberation are at first necessary to carry an organized defensive position, but when only improvised defences are to be dealt with, rapidity in the attack is all-important, thorough reconnaissance must be forgone, any guns on the spot must be used for preparation and support, even if they do not belong to the division engaged there, and the absolute centralization of command must be abandoned. However, if the Instructions had their faults, they realized great progress in many points, *liaison* between the infantry and the commander of the artillery showed an important advance. The rolling barrage dependent on the pace of the infantry, took the place of the old barrage advancing by bounds, and the infantry accustomed themselves to pressing up to the barrage, thus to a great extent surprising the enemy. Counter-

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battery work, whether for destruction or neutralization, was so perfected that the Germans adopted it in place of their zone-fire. The signal service improved enormously, and artillery fire, directed from aerial photographs, attained great accuracy. The rapid organization of ground during an attack still left much to be desired; much earth was thrown up, but so disconnectedly as in most cases to be wasted labour, and formation commanders were enjoined to decide rapidly, and transmit their orders for earth-works in the form of plans, to ensure better co-ordination. Reserves were to assist. At Verdun, and later on the Somme, motor-transport was used for the first time on a large scale, and was organized on the model of railway traffic.

Lessons of the Defence.—The battles round Verdun and the Somme took place before the defence had realized the preponderating effect of the intense and prolonged bombardment brought to bear by the attack. Too much attention was given to holding the foremost trench, and retaining every yard of ground while the aim and object of defence—to subject the enemy to greater loss than he can inflict—was lost sight of. Both sides recognized the necessity for plans showing the details of intended reinforcements, and the part to be played by each unit, and also the efficacy of promptly executed counter-attacks. Battalion and Regimental Commanders are the soul of the defence. The French soon realized that the attacker, if provided with sufficient resources, could capture the foremost trenches without the infantry firing a shot; the principal position of resistance was therefore organized somewhat to the rear. The enemy's artillery preparation must be discounted by deepening the defence, holding the advanced trenches only lightly and arranging for counter-attacks, siting the essential defensive elements, such as machine-guns, automatic rifles, and observation-posts, away from the infantry trenches and carefully camouflaging them, and by employing shell-proof shelters and underground communication trenches. The system of centres of resistance having been condemned at Verdun, continuous lines of trench were again used with supporting points enmeshed in them. It was found at Verdun that even the débris of trenches could be usefully held at the moment of the assault. To aid their infantry, the defenders' artillery must be decentralized and organized in groups corresponding to the infantry formations in line, but this specialization is limited by the necessity for obtaining, when required, powerful concentrations of fire. The tactics of the defenders' artillery, when superiority has been won in good time, is to reply to every concentration by a similar preparation, to every increase of violence by a corresponding augmentation of fire, and thus to overwhelm the assaulting troops before they can launch their attack. This is the *offensive counter-preparation* used with such excellent effect at Verdun. As the artillery preparation may destroy all telephonic communications over a great depth, other methods of communication must be in readiness, such as runners, flares, carrier-pigeons, visual-signalling, wireless, etc. Every man must be trained in mining and sap, and the moral factor is of greater consequence than ever.

The German conclusions are much the same as those of the French.

(To be continued.)

A. R. REYNOLDS, *Colonel.*

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REVUE MILITAIRE SUISSE.

No. 10.—*October*, 1921.

Operations on the Sangarios.—Colonel Feyler gives an account in the original article of the operations of the Greek Army against the Turks during the period August 14th–September 13th, 1921. These operations divide themselves into four distinct phases, viz., a stragetic movement towards the E. from Eski Chehr to the Sangarios ; a seven days' battle on the E. bank of the Sangarios and on those of its tributaries, the Gkéouk and Katranki ; a lull of ten days ; and the retirement of the Greeks to the W. bank of the Sangarios. After giving a description of the theatre of operations and stating in outline the movements of the opposing forces, Colonel Feyler comments upon the main features of the operations. The advantages gained by the Greeks in the operations on the Gkéouk were, he points out, that their Lines of Communications became perpendicular to their front and; at the same time, were shortened to two-fifths of their former length ; further, it also became possible for the Greeks again to bring into use the Eski Chehr–Sangarios railway. Against these advantages, on the other hand, are to be set off the fact that the casualties suffered were heavy and the Greeks did not gain, either politically or stragetically, a success sufficiently definite or decisive to compensate them for the losses incurred.

The Reichswehr.—The original article is a continuation of one on the same subject begun in the July number of the *Revue*. In the contribution under notice Major de Vallière deals with the death agonies and dissolution of the old Army of the late German Empire, and also touches upon the German Revolution and the Armistice which brought the Great War to a close. He points out that if General Maerker's views are to be accepted, the *foul work of disorganizing* Germany's fighting forces was initiated simultaneously with the outbreak of war. Haase openly stated in 1919 that the German Navy began working for a Revolution at the beginning of 1915. It is, of course, well known that there were, in 1917, mutinies in the German Fleet, whilst it was on the high seas : it was in this year that the " rot " set in throughout the Teuton Empire. The Government and the Great General Staff did their best to find a cure, but their efforts proved unavailing. The Russian Revolution, no doubt, had a disastrous effect upon the discipline of the German people. The Kaiser's Divisions, which had come into contact with the Bolsheviks, became infected with the poison germs, and carried the contamination into their homes, whence it spread throughout the length and breadth of the land. The discipline of the German Army broke down seriously early in the War, owing to the disappearance of the professional class of officers and N.C.O.'s, who had been killed and wounded in very great numbers : the young " Kriegsleutnant," commissioned during the later years of the War, despite all the eagerness they showed to master their profession, never really inspired the troops with confidence in their ability to command men older than themselves. By 1918 the casualties in the ranks of the officers of the German Army totalled 60,000, of whom 46,815 belonged to Prussian units. Apparently Ludendorff was fully convinced in September, 1918, that the German

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Army was badly beaten and could no longer hold out: on October 1st of that year he telegraphed to Berlin, urging that an armistice should be arranged forthwith. Mutinies broke out at camps on the Lines of Communications about this time, and on the 28th *idem*, the German sailors hoisted the signal for the Revolution, and refused to take their ships out of Kiel Harbour. Thereupon Noske, the socialist, was appointed Governor of Kiel and restored order with an iron hand. Later, disorders occurred at Hamburg, Bremen, Munich, &c., and on November 9th, Scheidemann proclaimed a Republic from a window of the Reichstag, and on the same day Liebknecht broke the Red Flag on the staff of the Emperor's Palace at Berlin. In these circumstances, those representing the old Government could not do otherwise than sign the armistice. The withdrawal of Hindenburg's Army to the Rhine then took place, and the old Imperial Army ceased to exist.

NOTES AND NEWS.

France.—A special correspondent calls attention to the fact that the Second Part of the Official Instructions relating to the training of the French Infantry has recently been published. The First Part was published in February, 1920, and deals with the preliminary training of the infantry soldier and drill movements: the Second Part treats of the "Infantry Combat," and is the first expression of official opinion, since the conclusion of the Great War, on the subject of infantry tactics—Lieut.-Colonel Lachèvre is the author of the latter volume. The subject matter is handled under four main heads: a preliminary statement, in which war is examined in all its aspects; general remarks upon the employment of infantry; the offensive combat; and, finally, defensive positions. The highest praise is given to the compiler of the Second Part of these Instructions for the manner in which the whole subject has been treated by him.

No. 11.—*November*, 1921.

Rapidity of Attack.—The original article is by Jean Fleurier, who modestly states that he played but a minor part in the great drama upon which the curtain has not yet been finally rung down. In contributing an account of his experiences, M. Fleurier's intention is not so much to trace the changes in tactics which developed during the period 1914–1921, nor yet to criticise the measures adopted on the battlefield, as to indicate the manner in, and the means by, which rapidity in attack can be made to serve the ends of success; he was much impressed with certain plans which proved eminently suited to the present-day armament of troops, and is consequently impelled to place the same on record. M. Fleurier points that when the Great War broke out in 1914, both the German and French Armies had fully imbibed the doctrine of the "offensive," and extracts are given from War diaries, &c., to show how deeply embedded this doctrine had become, not only in those who were called upon to act as leaders of troops in the early phases of the War, but also in those of the rank and file who first rallied to the colours on the call to arms. The want of success responsible for the three

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years' hold-up of the Entente troops on the Aisne is attributed by him to the too great expectations regarding the efficacy of the artillery bombardment as a means for neutralizing machine-gun fire from defensive positions, whilst the attacking infantry were rushing forward withholding their own fire. The system of swiftly-delivered attacks, which, in 1915, failed to carry the line of obstacles, was, M. Fleurier points out, succeeded in 1916 by " ram " tactics, which, in their turn, were in 1917 replaced by a method of attack consisting of movements planned to be carried out with a regularity similar to that associated in men's minds with the movements in the mechanism of clockwork. In M. Fleurier's opinion it was in connection with the operations of September, 1918, in the Champagne, that there will be found the perfect model of an attack delivered with the rapidity essential for success. In these operations the objectives were initially screened behind an impenetrable veil of mystery; night marches were carried out with the greatest secrecy, and with such methods as to secure the greatest comfort to the troops, and to inspire in them the utmost confidence; reliefs were effected with such rapidity and order that the units which had to break through were brought into their correct positions without confusion or mistakes just 48 hours in advance of the " zero " hour; the artillery preparation preceding the attack, although lasting but a few hours, was exceedingly effective and violent—it silenced the German artillery and put its counter-preparations out of gear. Once the " *unités de rupture* " were sent forward on their errand, they continued their advance for two long days without a halt, and ended up by capturing 22 successive lines of trenches—on a depth of 7½ km. The details of the organization whereby the foregoing results were secured are given in the original article, which provides an interesting account of the tactical developments during the Great War.

Responsibilities of the Soldier.—An incident is described in the original article which bears upon the problem of the responsibility of soldiers when employed upon quasi-military duties. During the mobilization of the Swiss Army in connection with the Great War, sentries, furnished by a squadron of the 18th Dragoons, posted near the village of Benken, (Canton of Zürich), saw a motor-car approaching them; they challenged it, but as it continued its course without heeding the order to halt, the sentries, in accordance with the instructions issued from Army Headquarters, fired in the direction of the motor-car, with the result that the chauffeur and the owner of the car, who was riding therein, were both killed. Thereupon the Commander of the Squadron to which the sentries belonged was indicted for murder: he was acquitted. Subsequently, the widow and children of the owner of the car brought an action in the Civil Courts against the Commander of the Squadron and two of its N.C.O.'s, claiming 40,000 francs as damages. The plaintiffs were non-suited. The judgment of the Federal Court, which finally disposed of the action, is published in the original article, and sets out the Swiss law on this very difficult question of the responsibilities of soldiers when employed upon what are practically police duties.

Search for a New Discipline.—Captain Cingria, the author of the original article, considers that in Switzerland military discipline is

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paralysed by two serious failings on the part of those responsible for its maintenance: a superstitious reverence of archaic forms and ceremonies, and the desire to render as complicated as possible certain simple and meritorious principles handed down by tradition. Soldiers are, he points out, ultra-conservative, and he expresses the opinion that the present-day methods of discipline and the ideas prevalent in relation thereto no longer conform to the necessities of the times and to the present-day organization of society. However, we are not told what is to take the place of that which is declared to be obsolescent.

Greek Second Army Corps at Kutahia.—Colonel Feyler describes, in the original article, the operations of the Greek Second Army Corps in Anatolia, which took place in July, 1921: the Turks were, at this time, occupying a front of approximately 130 km. in extent on the line Eski Chehr–Kutahia–Afiun Karahissar. Three Greek Army Corps were set in motion against the Turkish position; the First Army Corps advancing from the W. of Ouchak, was ordered to drive the enemy from the positions held by its left wing W. at Afiun Karahissar; the Third Army Corps was directed from Brousse against the Turkish centre at Kutahia, whilst the Second Army Corps (forming the Greek centre) was sent forward from the line Dounli Selki–Serai to occupy the mountainous country of Umali Dagh and Kara Boujon, where it was to halt until the First Army Corps came into line with it. The mission of the Second Army Corps was to act in co-operation with the First Army Corps: these two Corps were to deliver an attack in the general direction of Kara Tepe with the object of cutting the enemy off from the roads leading to Seindi Gazi and Eski Chehr. The instructions issued to the Second Army Corps are set out in detail in the original article and the operations based thereon are given in outline: the Greeks attained their objectives, after having driven the Turks out of their positions with heavy loss. Colonel Feyler, commenting on the operations of the Second Army Corps, expresses the opinion that it achieved all that could have been expected of it.

NOTES AND NEWS.

France.—A special correspondent calls attention to some of the important changes which have taken place at the Headquarters of the French Army. General Margot has become head of the *Direction de l'Infanterie*, in place of General Lagrue; General Nivelle has retired from the *Conseil supérieur de la guerre*, and has been succeeded by General Nollet; General Gassouin, of the General Staff, having obtained an important appointment in a commercial company, has retired from the Army, and General Raguenau has been appointed a *sous-chef* in his place. General Serrigny has been placed in charge of the Historical Section of the General Staff. The Army Law provides that the Air Force shall be organized in four Regiments; experience has shown the desirability of grouping these Regiments in Brigades, and they have accordingly been formed into three Brigades, with Headquarters at Paris, Dijon and Lyons, respectively. Further particulars concerning these groups are given in the original notes.

W. A. J. O'MEARA.

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A STUDY OF THE NEW FRENCH INFANTRY REGULATIONS.

By CAPT. B. H. LIDDELL HART.

THE provisional edition of the post-war Infantry Regulations of the French Army is well worthy of study by all British officers, both for its general tendencies and its detailed methods. For those, however, who lack the time to study it in the original, or who are not able to obtain access to copies, this brief summary may be helpful, and the comments prove of interest. The *Règlement Provisoire de Manœuvre d'Infanterie*, as it is entitled, is composed of three volumes; a first part which deals with the technical preparation or training of infantry, a second part which is concerned with infantry in battle, and an annexe which contains diagrams, ceremonial, and methods of instruction.

Obviously it is beyond the scope of an article to compress these three volumes into even a condensed version of the original. Hence it is judged best merely to outline the main points which are of interest to British readers, and to accompany them by a running fire of comments from the standpoint of an English military writer. The author has recently been asked by the *Revue Militaire Générale* to contribute a critical study of the French Infantry Regulations, and for convenience of arrangement it appears best in this article to follow out the main lines of his study for the French review, taking the subjects for comment in the order in which they appear in the manual.

THE INTRODUCTORY REPORT.

The Regulations open with a long and masterly report to the Minister of War from the authors, under the signature of the Director of Infantry at the French War Office. After declaring that the late war has proved once more that victory rests with the combatant whose moral qualities are the higher, though only on condition that these are supported by adequate material resources, the Regulation reasserts the truth that, despite all the changes in armament, the task of infantry still remains the same: to conquer and hold the ground. So long as the present organization of the arms of the service continues this rôle will hold good. The conversion of armies into pure tank forces is likely to be delayed by many causes—not least by the inertia of conservatism

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common to all governments and war offices. Let us consider existing organizations and conditions.

The more terrible the destructive power of weapons, the more does unprotected man seek impregnable shelter in which he can escape their missiles. No other arm, save infantry, has yet proved itself capable of going in and dislodging him from this shelter. Moreover, victory being a moral effect is the result of a conviction of inferiority, a demoralization, which is driven into the defender by a concrete proof. This proof lies in being driven back, not a few yards only—his *morale* will survive this—but being hurled back in confusion from which he feels hopeless of recovery. The break-up of organization, far more than actual losses, is the test of defeat. The dislodgment of the enemy, which is thus the decisive act of battle, still rests with the infantry, because it is the only arm which is universally mobile in any given locality. Infantry alone of the arms can move over every type of terrain, penetrate any shelter, and fire from any kind of position.

The report goes on to declare that the experience of the war has clearly proved that, in order to accomplish this mission, infantry cannot fight alone, and that the support of other arms is essential.

Few will deny that this is and will remain true of all war waged against enemies properly organized and equipped with modern mechanical weapons and resources. It might perhaps have been qualified by a reference to the need for self-reliance when opposed to ill-equipped or disorganized opponents. It is well to impress on infantry that, however valuable the support of the auxiliary arms, it should be accustomed to depend on its own powers, and not depend wholly on that outside support. France, like Britain, is a colonial power whose infantry are often called upon to face tribal levies with little extraneous aid from the more mechanical arms. Moreover, even in battle against well-equipped adversaries, there are moments when infantry may overcome local resistance or exploit the temporary disorganization of the enemy after the storming of a position, solely by its own means. Is there not some risk of cramping the self-reliance of infantry if we set down, in any place, such a dogma, as that quoted from the report, without qualification ?

The report then draws attention to the Regulations of 1875, issued after the experiences of the war of 1870. It lays stress on the truth that, whilst the lessons of war are still fresh in the memories of the actual combatants, the deductions are likely to be more true to reality than those subsequently culled in the years of peace from the unreal experience of the rifle range and training ground. At the end of a war the test imposed by the bullet and the shell has displayed the weak points in the pre-war doctrines ; the methods in use have been hammered out of the molten ore of battle experience.

The 1875 Regulations placed at the head of their general principles

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the axiom of the preponderating importance of fire as a mode of action. This axiom was the fountain-head of all the deductions of those Regulations. The subsequent Regulations down to 1914 modified and weakened this primary assertion.

The report renews the original assertion that of the two elements which, combined, form the infantry manœuvre, action by fire has the greater weight.

"It is not only 'every attack in dense formation that fire power renders impossible over exposed ground,' but every progression, even in dispersed formation, if the ground can be effectively beaten by fire. The power of infantry fire has become such that any terrain, even when it appears empty of defenders, can no longer be crossed without heavy losses so long as combat groups remain resolved to defend themselves energetically and continue to make use of the weapons." Therefore the French emphasize that the only way in which movement can be made possible is for the defender's fire to be beaten down and kept down until the attacking infantry can assault him. A sentence from the report which should be inscribed on the mind of every commander is that which declares that "a progression weakly supported by the artillery, and *a fortiori* not supported, can only be attempted against an enemy in a definite state of inferiority, moral or numerical." If we make a mental addition of the words "or tanks" after "artillery" the weight of the deduction is strengthened.

It was a lesson that cost countless thousands of wasted lives before it was taken to heart. Let it be hoped that the generals of the future will not demand further and more costly proof of its truth.

The report points out that "this lesson of the preponderant importance of fire does not detract from the other element of the infantry manœuvre—movement, which remains the only decisive factor. The two elements are inseparable. The object of fire is solely to pave the way for movement. Movement is the means by which one conquers the ground and puts the adversary out of action," which acts are the visible tokens of success. "The advance should not wait for the complete neutralization of the fire of the defence, but should be pushed at every opportunity when fire has made it possible with reduced losses." "Infantry must not fear a certain proportion of loss."

To achieve this will to advance, however, the trainers of infantry must inculcate the spirit of self-reliance, of dependence on "ourselves alone" in the last resort. Let infantry be taught to value the aid of the other arms as a boon, but not expect it as a certain buttress of its own action.

The next paragraphs in the report are ones with which many English officers will be at variance. Here the doctrine is laid down that in the new methods of combat, everything gravitates around

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the automatic weapon (machine-gun and *fusil-mitrailleur*, which corresponds to the Lewis gun). All the members of the *groupe de combat* only exist in relation to the automatic weapon, according to whether their individual rôle is "to move it, serve it, feed it, or protect it."

It would appear to the writer that in this dogma there are grave dangers of a cramping of mobility and initiative. The mobility of the automatic weapon, its quickness in engaging a target, its handiness and adaptability to fire from any spot, still compare unfavourably with the rifle. Even its high rate of fire carries the drawback of a too speedy and not always so economically profitable usure of ammunition, and a consequent difficulty of supply. These defects cannot altogether compensate for its volume of fire and lessened dependence on the emotions of the firer.

The writer feels that the French have undervalued the possibilities of the rifle in the hands of well-trained infantry. Its potentialities were demonstrated to the world by the British infantry of 1914. Even while bearing in mind the difficulties imposed by the short period of training of the French infantry, one feels that their natural quickness and aptitude for movement and the use of ground would make the rifle still a formidable weapon, on its own merits, in their hands. The French section, corresponding to the British platoon, is divided into three groups, each consisting of two *équipes*, an automatic rifle *équipe* and a rifle *équipe*. The latter has the duty of protecting and covering the automatic rifle *équipe*. To tie the rifle *équipes* so closely to the vicinity of the automatic weapon, as is done by their incorporation in the same group, must surely lead at times to a lack of manœuvring power and a failure to make the fullest use of all opportunities to infiltrate between and turn the flanks of enemy posts and *points d'appui*. A rifle *équipe* charged with the duty of protecting its automatic weapon can scarcely make such full use of the possibilities of movement and outflanking as one that is free from this duty and has the full width of the frontage of the "section" in which to manœuvre. One feels that the British organization makes better use of that mobility in which rests the claim of the infantry arm to remain a decisive factor in battle. Our rifle sections retain the full advantage of their superior power of movement for infiltration and outflanking the enemy defence posts.

The report then discusses the combat group. It declares that the isolated rifleman no longer exists. The group is the cellule for training and for battle, being the largest body which can be directly controlled by the voice and hand-signal of its chief.

In the Regulations of 1875 the unit of combat was the company; later it became the section (platoon); then the half-section of about 20 men at the end of the late war.

Experience showed that even this strength was still too large

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and too vulnerable. Thus the group is now made the primary cellule of infantry.

The report points out that in order to avoid the increasing deadliness of firearms, infantry has been forced to become more and more dispersed; that the interval between the groups tends towards a maximum which is only limited by the double necessity of keeping touch and of covering the intervening space with fire; that the strength of the unit of combat tends towards a minimum which is limited only, on the one hand by the need for retaining control, and on the other by the obligation of ensuring the service and protection of the automatic rifle.

The report speculates on the question whether this evolution will eventually terminate in two or three men enclosed in an armoured and mobile shell. It concludes that the group, however, meets the needs of the moment.

But that "the conception of the group results from the necessity of serving and protecting the automatic weapon," is an opinion with which the writer cannot agree. He feels that the origin of the *groupe de combat* is anterior to the invention of the automatic weapon, and is to be ascribed to far more fundamental and psychological causes. The group is born of human nature. Fear is always worse when man is alone. When modern fire enforced dispersion, long extended lines were introduced. But human nature, lonely and leaderless as a single peg in an unnatural featureless line, instinctively sought companions and a leader. Thus the group formed itself, even in past wars, whenever the unnatural mechanism of unarticulated lines broke down under fire. That value of personal example which inspires the soldier and makes him forget fear is only applicable to a handful of men who can feel the direct influence of a leader. In battle man needs some rock to which to hold fast—the artilleryman has his gun, the aviator his aeroplane, the infantryman his group leader. The little group of some half-dozen, or slightly more, men is large enough to be an effective instrument of fire or assault, which the isolated skirmisher is not, while it is small enough to be easily controlled and guided by the best-covered approaches and not to attract undue attention. It is suggested that the French group of a leader and twelve men is too strong if the ideal of control, mobility, and invulnerability is to be attained. The writer feels that to overcome this defect by dividing the group as in the French Army is to break away from the ideal of the group. At the same time, he admits that the English group of a leader and six men may not possess sufficient fire-power, assaulting force or insurance against becoming ineffective owing to a few casualties. There are strong arguments in favour of a strength of a leader and eight men.

Next, the French report discusses the problem of whether normal formations should be laid down. It points out that the Regulations

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of 1875 thought it wise, when introducing dispersed order, to determine normal formations for battle, applicable to all situations, and subject only to slight modifications. The later Regulations reacted strongly against this tendency, and gave entire freedom to commanders—freedom which has too often been synonymous with chaos. The report then proceeds to discuss the arguments against normal formations and distributions, above all that no two situations in battle are exactly similar. Wisely, however, the report stresses the fact that if the Regulation is written in such a wide manner as to cover every possible case, it will be so full of vague generalities and reservations as to be unintelligible to the bulk of officers; an accusation which can be levied against our own manuals, in the past at any rate.

The French point out that in any future war only a few will have had actual war experience and fewer still the ability to draw correct deductions from their experiences. In war an officer has often to take over a new command with which he is unacquainted and under difficult conditions; to act without full information and *liaison*. For these reasons, the report signifies that it was decided to illumine the text with diagrams of normal formations and distributions. All the reservations are then catalogued on the succeeding page of the report, and the pages of the actual Regulations left free of those bewildering and contradictory considerations and reservations which sap the initiative and befog the brain of the average officer. Experience of war tends to prove that more mistakes and disasters are due to ignorance and confusion than to too great definiteness. In battle it is better to adopt a formation or disposition which does not quite fit the situation of the moment and carry it out with resolution, than to hesitate, to lose direction, and fall into confusion. The writer has always pleaded for a more definite tone in the manuals, and for the introduction of a framework upon which the junior officer can develop his knowledge as his experience widens. Hence it is especially gratifying to find that the French authorities have recognized the need.

The next section deals with attack and defence. "The simple idea that all infantry fighting is conducted by a certain number of groups disposed chequerwise, beating the ground in front of them with fire and lending mutual support, frees the Regulation from all excessive discrimination between attack and defence. Besides, the combat is never offensive or defensive from beginning to end, but alternates between attack and defence. In either phase, the action of the group is practically the same.

It is the same idea which the writer emphasized in his lectures at the Royal United Service Institution and School of Military Engineering in November, 1920 and January, 1921. (See *R.E.J.*, April and May, 1921). When it has been made clear that there is no

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fundamental dissimilarity between infantry attack and defence, the young leader's path to knowledge will be smoothed. So long as he thinks of the different phases of action as watertight compartments, his mind is moving in a fog. The only notable difference lies in the increased time and opportunity for selecting and preparing fire positions which is afforded to the defence.

The report next emphasizes that the Regulation uses the title "Defence of the Ground" for the part which deals with infantry in defence, because its authors wish to insist above all that the aim of the defensive attitude is to keep hold, in spite of the enemy, of a certain stretch of the ground, on which it has been previously resolved to stop him and to beat him. The Regulation is definite that for troops who have occupied a position there can be no so-called elastic defence by gradually ceding the ground to the enemy. That is retreat, not defence. It adds that the inviolability of any position rests in the quality of the defenders and their ability to form a complete network of fire rather than in the natural strength of the ground.

The report shows how the idea of the "group" as the basis of infantry tactics allows great elasticity in matters of organization. Inside the company the group is the only fixed unit. The strength of the group, thirteen combatants, remains invariable. If casualties occur, the number of the sections and groups may be reduced, but the strength of the actual group must never be appreciably reduced (*i.e.*, below ten). The Regulations are therefore framed in such a manner that they apply equally to the company with its full strength of 12 groups and to the company reduced, if necessary, to two sections, each of two groups.

The report then gives the reasons for dividing the Regulation into two distinct parts: "the technical preparation of infantry" and "infantry in battle." In this it reverses the attitude of previous Regulations; on the one hand, in order to avoid the bad results due to unimaginative officers who have tried to repeat in battle the precision and alignment of the parade ground; and on the other hand because some officers, regarding close order as mainly a method for use in the approach, have neglected its precise execution.

Some British officers would, however, be inclined to assert that we have suffered equally in recent times because our drill movements have borne no relation to those which are used in battle, during the approach in particular. Battalion commanders have been apt to concentrate on attaining perfection in the drill movements, the reason being that excellence in drill is much more easily discernible to the casual inspecting officer and thus credit is more easily gained. The better "field exercises" are carried out, the less apparent they will be to the inspector, and the less there will be for him to see. Thus, however well-intentioned the inspecting officer may be, there

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is a natural tendency for him to base his comparisons to a large extent on efficiency in drill. As a result, too great a proportion of time is devoted to drill, to the detriment of field training. Moreover, a further danger lies in the retention of these antiquated drill and ceremonial exercises which were in former days applicable to battle. As they are the only parts of the soldier's training which have been repeated so often that they have become a habit, he is at a loss when he goes into battle, and is told to forget that to which he has become accustomed. As human nature in battle is apt to retain only that which has become instinctive, it happens that in moments of crisis men have been known to resurrect their parade-ground habits and advance in close-packed, strictly aligned waves.

The report emphasizes that the authors of the revised Regulation have taken particular care to do away with all connection between arms drill and firing exercises. Any attempt to insist on smartness and precision in firing exercises is forbidden. The method of executing the latter by command, and even assuming them in a regular manner, is suppressed. The sole method of fire in use is that of fire at will, individual or collective.

Collective exercises are divided into close-order drill, exercises for obtaining flexibility, *i.e.*, battle drill, and field exercises. The first two come within the scope of the first part of the Regulation, and the last within the second part. Close-order drill is regarded primarily as a means to cohesion and discipline. Precision and regularity of execution are the essentials. Its secondary purpose is by the medium of ceremonial to heighten the *morale* both of the soldier and of the nation at large which witnesses this side of the training. To achieve these aims the close order drill has been simplified and reduced to the fewest possible movements.

The *exercices d'assouplissement*, or battle drill, are for the purpose of quickening the power of manœuvre and increasing the mobility of units in field exercises and deployments. They are therefore executed on the briefest indication, or even signal, of the instructor. They are solely a form of gymnastics, and no tactical scheme is needed, nor should the regularity of close-order drill be aimed at.

Field exercises are the culmination of the training. In carrying them out, the aim must be to reconcile initiative and cohesion. A tactical hypothesis is always necessary, and one should use the ground as it is, not introduce imaginary modifications. Exercises should usually be carried out on the supposition that there are other similar units working on either flank, as will normally be the case in battle. In the writer's own experience it is a most common fault, particularly in the past, for small units when training to act as if they were isolated and had an unlimited zone of action in which to manœuvre. It is a dangerous fallacy and leads to officers attempting wide outflanking movements which would be impossible in battle,

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whilst they fail to realize the problems of co-operation with the units which would be acting on their flanks.

The report then lays down that drill and field training should be taught to the recruit simultaneously and begin together. Each has its own disciplinary value. Moreover, the idea of direction is more important than the idea of alignment, which is only of use in parade movements, and should therefore be implanted primarily.

This reform is one which the writer has always advocated. It ensures that the inevitably monotonous instruction on the drill ground shall not cramp the soldier's initiative and intelligence during his most plastic period. The motive of his existence, that of combat, should be instilled into him by simple demonstrations and exercises at the earliest moment on joining, and kept before his eyes throughout all stages of his training. Again, first impressions are always the most abiding, and the dangers of an undue sense of alignment have been proved on many recent battlefields.

THE REGULATION.—FIRST PART.

Technical Preparation of Infantry.

The opening chapters of the Regulation itself deal with the general system and scheme of training. Though interesting, they contain little that calls for notice in this brief survey. They differ only in detail from our own Regulations. Chapter VIII, "Definitions and General Rules," contains one or two points of interest. It is laid down that extended points of direction beyond the allotted objective should be given in order to ensure the exploitation of unexpected successes after the rupture of the first positions. In the encounter battle particularly, it is almost impossible for commanders to fix objectives beforehand which will be proportionate to the capacity of their sub-units, for they are inevitably ignorant as to the resistance which the enemy will offer at any particular point. This measure should certainly tend to avoid the danger that unenterprising subordinate commanders may rest on easily gained objectives, and let slip opportunities for further advance.

Again one notes that definite sectors or "zones of action" are restricted to battalions or higher formations. Thus the company or "section" can manœuvre freely within the battalion zone, taking full advantage of covered approaches and gaps opened by the progression of neighbouring companies or sections.

Chapter IX deals with the composition of the regiment, which comprises several battalions, usually three. The battalion consists of a headquarter group, three ordinary companies, a machine-gun company, a section of accompanying weapons (mortar and accompanying gun).

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The ordinary company at war strength is composed of a head-quarter section and four combat sections. In peace it is generally reduced to three. The section is normally composed of three groups, if there are sufficient effectives. The group consists of an *équipe* of automatic riflemen and an *équipe* of riflemen composed thus :—

Personnel.	Armament.
1 N.C.O. chief of the group	Rifle
Équipe of Automatic Riflemen.	
1 Corporal chief of the *équipe*	Carbine
1 Firer	Automatic rifle and pistol
1 *Premier pourvoyeur* (feeder)	Pistol
3 *Aides-pourvoyeurs* (carriers)	Carbines
Équipe of Riflemen.	
1 Corporal chief of the *équipe*	Rifle
1 Grenade-thrower	Carbine and pistol
1 Rifle grenadier	Rifle
3 *Voltigeurs* (Riflemen)	Rifle

A British officer will probably prefer the division into four sub-units throughout the organization of infantry. An even number of sub-divisions is more convenient for reliefs and simplifies the task of the officer in learning how to apply the principle of economy of force in the distribution of his sub-units according to the different situations of battle. Changes in command are rapid in battle, and the platoon commander of the morning may be commanding the battalion before nightfall. The uniform four sub-unit organization diminishes the points of difference in the tactical handling, and so makes it simpler for officers to fit themselves to take command of higher units when called upon. It enables us to condense our Regulations and to create a framework of principles common to all degrees of units, so smoothing the path of the average officer whose memory is apt to be indifferent and whose habit of thought is liable to become confused.

DRILL.

The new French system of drill is a model for all armies. Nothing more workable and simple could be wished for, apart from the question of organization which we have just discussed. All movements in line are abolished. They are obsolete in war and much valuable time is wasted in learning the strict alignments and changes of direction, apart from the dangers of instilling habits which have often proved disastrous in battle. Alignment is, above all, the one habit for individuals and groups to avoid in battle. Line is only used in forming up for inspection and for moving a few paces to a flank with the rifles at the trail. In order that the line can move off in

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column at a simple "right turn," a new method of measuring the interval between men is introduced. The distance between two men marching in column must be a yard, and therefore the interval in line is the same. This interval is obtained by each man extending his left arm to touch the shoulder of his neighbour on the left.

The Drill of the Group.

The group assembles either in line or in column. If in line, the *équipes* are side by side, forming a single rank (*Figs.* 1 and 2), or one behind the other, forming two ranks. The automatic rifle group is normally on the right in the first case and in front in the second case.

If in column, each *équipe* is in single file. The group may be formed in *column by one* with the automatic rifle group leading (*Fig.* 3); or in *column by two* in which the two *équipes* are side by side, the automatic rifle *équipe* normally on the left. The group normally marches in *column by one* or *by two*; these formations are equivalent to file or single file respectively. As can be seen, it only requires the simplest command and movement for the group to change from one formation to another, to increase the intervals between the *équipes*, or to deploy it into *skirmishing line* at five paces interval.

The critic will note that the *équipe* marches in single file (*colonne par un*) and fights in extended line (*en tirailleurs*). Single file, however suitable for moving along any defile, has the objection that men have a tendency to follow the leader blindly without troubling to see where they are going. Thus they lose the sense of direction. Both on this score and that of vulnerability to fire, *arrowhead* formation, which was advocated by the writer in his lecture at the R.U.S.I. in 1920 and is now authoritative (*vide Infantry Training*, 1921), is surely preferable. As a fighting formation it is no more vulnerable than extended line. It is capable of fire to any direction; each man can see where he is going; whilst the leader, being at the head, can guide it to take advantage of cover or to move obliquely to outflank an enemy post.

Drill of the Section.

The section assembles normally in *line on three ranks* (*Fig.* 4), or in *column by three*. In the former case the groups are successively behind each other at a distance of a yard. This can be changed to *column by three* on the command "Right (or left) turn." The latter is the normal formation for movement. A change of direction is effected by the commander extending his arm towards the new direction and if there is an obvious mark, giving the order "Direction (such a point)."

In battle drill hand signals are used as far as possible instead of commands

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It is interesting to note that the definition of the section, as the smallest unit capable of manœuvring from two directions concurrently, is identical in idea with the definition given by the writer in the lecture previously referred to, and in *Infantry Training*, 1921.

THE DRILL OF THE COMPANY.

The company is normally formed :—

(i) In *line of sections by three*, the flank of each section being six paces interval from the next (*Fig.* 6).

(ii) In *double column*, which is equivalent to our square formation. Two sections are on each flank, one behind the other, each section being in *column by three*. Intervals and distances are six paces (*Fig.* 7).

(iii) In *column by three*. The sections, each in *column by three*, are one behind the other at three paces distance. This is the normal column of route (*Fig.* 8).

The simple movements which are needed to change from one formation to another can be deduced by the reader, without the need for tedious explanation.

In battle drill the company is exercised by modifying these formations according to the ground, in deploying the sections, and in varying slightly the direction.

THE DRILL OF THE BATTALION.

In close order and battle drill the machine-gun company acts as a fourth company. The section of accompanying weapons moves with it.

The battalion is normally formed :—

(i) In *battalion column*, with the companies one behind the other, each in *line of sections by three* (*Fig.* 9).

(ii) In *column by three*, with the companies one behind the other, each in *column by three*.

(iii) In *double column*. The companies are each in *column by three*.

(iv) In *line of columns*. Each company is in *line of sections by three*.

The battalion manœuvres in drill similarly to the company. In battle drill the commander gives his orders by voice, hand-signal or message. In the latter case he can give the signal for carrying out the instructions by a long blast followed by a short blast of the horn.

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SECOND PART.

Infantry in Battle.

The introduction points out that the twofold aim of infantry, reduced to its simplest element, is either (i) to advance in spite of the enemy, in order to disorganize his dispositions and destroy his power of resistance; or (ii) to prevent the enemy advancing by holding the ground that one has occupied or wishes to acquire.

The aptitude for passing instantly from the offensive to the defensive attitude, or inversely, in the course of the same combat must be developed in the troops so that it becomes instinctive. The lower one descends in the scale of units the less difference there is in the two forms of action. This is the lesson the writer stressed in his R.U.S.I. and S.M.E. lectures when he declared that the defence is only the attack halted; that every infantry unit which halts its advance is capable, on account of its open and self-contained formation, of offering an immediate resistance to hostile attack or counter attack; it is a human tank possessing both offensive power —its weapons and mobility—and protective armour—its open formation preventing surprise.

From the moment when contact is made, its maintenance becomes the vital factor in security. For every small unit, the first requirement in exploiting success is to keep contact with the enemy in the direction assigned.

The Regulation insists that though fire is preponderant, it is always necessary for infantry to "*agir par le mouvement.*" This truth cannot be too strongly insisted upon. If fire alone could win victory there would be no place in modern armies for infantry; the auxiliary arms can supply a far more potent fire. But infantry can carry its fire to close quarters and supply that tangible human threat which causes the enemy to run. Important as is fire for paving the way for the infantry advance, it is in the legs of the infantry that the decision rests. For this reason some would oppose the allotment to infantry of weapons which may induce it to rest content with firing on the enemy from more or less stationary positions. If the automatic rifle or Lewis gun is to be allotted to platoons it must surely be treated as an essentially mobile weapon which must neither be allowed to hamper the pace of the infantry groups, nor indulge solely in more or less distant covering fire. The latter tendency would appear not to be confined only to the French.

The Regulation decrees that infantry units in attack should continue to advance even though units on their flanks are checked or delayed. This is qualified by the proviso that they must use their reserves to hold the gaps which their quickness of advance creates on the flanks and must halt when they can no longer ensure this. It appears to the writer that there lurks herein a danger of hindering

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the initiative of the infantry units in exploiting the soft spots which they find or make. If they are so concerned with their flanks it is probable that the speed of their advance will slow down so quickly that the advantage of the attack and surprise will be lost. Such a method of attack as the "Expanding Torrent" put forward in the lecture previously referred to should discount the danger to the flanks and reconcile speed with security.

(Compare also *Infantry Training*, 1921, Section 35, paras. 13–14.)

In discussing the question of *liaison* the Regulation decrees the use of *liaison* agents. Every infantry commander, even down to the group commander, who employs his file-closer or senior soldier, details a *liaison* agent to keep him in touch with the situation and progress of his subordinate units.

This also is an idea long advocated by the writer, though it is omitted from *Infantry Training*, 1921, as issued. Officers of far greater experience have confirmed this belief, stating that in their experience junior commanders are too busily occupied at the important moments to give their first thoughts to sending back reports. A *liaison* agent means a saving of vital minutes in exploiting a sudden success or meeting an unforeseen danger.

In the part dealing with the employment of the infantry weapons the writer notes with surprise that the rate of fire expected from the French rifle is a maximum of ten shots a minute. The possibilities of an effective rate of fifteen shots a minute has been proved so often in the British Army that one feels that the French authorities are content with too low a standard. Possibly this explains the reason for their making the rifle a mere auxiliary to the automatic rifle.

The Regulation, like *Infantry Training* 1921, as issued, treats the automatic rifle merely as a means for supplying covering fire from the front. The writer, like many others of greater experience, is of the opinion that it should be regarded as a weapon of mobility. Where covered routes exist, the greater surprise and enfilade effect of the automatic rifle may advantageously be used for outflanking. In any case, even if it is used for fixing by fire whilst the rifle *équipe* outflanks an enemy post, the former should endeavour to progress ever closer to the enemy by bounds. There must be the threat of a forward spring in order fully to fix the enemy's attention.

The writer is surprised at the almost complete disregard in the Regulation of the possibilities of the smoke grenade for blinding enemy posts, and incidentally economizing ammunition.

Titre I.—General Characteristics of Infantry.

The Regulation divides the types of terrain into three classes:—

(i) Free of artificial obstacles.
(ii) Partially covered by improvised defences.
(iii) Fully covered by field fortifications.

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In each case the method of attack is to progress from objective to objective in the assigned direction. The combat really consists of moving the infantry from one *base de départ* which it has consolidated to another base, from which it will make a similar bound.

The Regulation divides the combat into four principal phases :—

(i) The approach.
(ii) The establishment of contact.
(iii) The attack, including the assault.
(iv) Consolidation or exploitation.

The French doctrine on these phases is as follows :—

1. The approach has its place either well in advance of the contact between the rival infantries or well behind the troops already in contact. In the approach, infantry does not make use of its own fire, either because it suffers little or nothing from enemy infantry fire, or because it has friendly troops in front. On the other hand it takes full precautions against artillery or aeroplane fire.

2. The phase of making contact entails the units of the advance guard deploying in order to reply to enemy fire. They reconnoitre the enemy by fighting, making progress by combining fire and movement, infiltrating between and outflanking the scattered resistances of the enemy, to break through his protective screen in order to locate definitely his main resistance. Then at last contact is truly made and a methodical attack follows in co-operation with artillery and tanks.

3. The attack is a combined operation aiming at the rupture of the resistance with which contact has been made. In the special case where the preceding phases have established the opposing lines at a short distance, the assault takes place at the start of the attack. It is made after thorough preparations, from a jumping-off position. The dispositions should ensure that the attacking troops debouch by surprise, in good order, and as a whole.

In the normal case the assault is a small local act constantly repeated. The centres of resistance are distributed both in breadth and depth. Thus the attack is a progression by the use of fire, intermingled with local assaults and continuing until the allotted objective is gained. The writer feels that the pre-war idea of a general assault was false to reality, and led to many costly failures. Assaults are better, because quicker, delivered by groups or sections than by battalions The opportunity for assault is momentary and must be instantly seized. A general assault allows this moment to be lost.

The French Regulation continues :—

The difference between the approach formation and the attack formation is that in the former case the aim is to avoid loss from fire, whilst in the latter the object is above all that the leading troops

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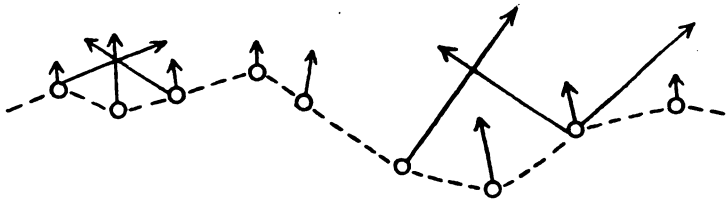
should provide all the necessary fire to pave the way to their advance. The attack formation comprises firstly an *echelon of fire*, corresponding to our *forward body*. Behind the *echelon of fire* come the *reserves* distributed in one or sometimes two echelons. Even the *echelon of fire* possesses a certain depth. The groups form a very irregular line, presenting salients and re-entrants.



Thus the groups can flank and mutually support each other. In deciding how many groups to allot to the echelon of fire, the essential is that the whole frontage should be covered by fire. The groups of the *reserve* will be disposed chequerwise to cover the intervals in the *leading echelon*. As groups in this echelon are put out of action they should be replaced from the reserve. At every halt in the advance, the immediate and automatic duty of each commander is to organize a system of cross-fire to form a complete barrage in front of him. Every commander down to the company, at least, should keep in hand a portion of his force as a *reserve* and should reconstitute it as soon as possible when they have been used. The purpose of the *reserve* is to ensure continuity of effort and to maintain the combat by reinforcements and replacements; to correct mistakes of direction by filling up gaps which result; to re-establish as intended a manœuvre which has gone astray; to give to the fractions which are engaged a certainty of being backed up; to exploit success to the full. In principle every unit that is engaged ought to pursue its effort to the full limit of its offensive capacity. It is the part of the command to judge whether the momentum of advance can best be maintained by relieving a leading battalion by one from the reserve, or sometimes one company by another. Inside the company, however, the groups are not relieved. The momentum of the advance is maintained by the gradual fusion of the *reserve* into the *echelon of fire*. Reserves should be pushed in where the enemy is giving way, not by piling up an accumulation of men in front of intact defences, which causes disorder and increased casualties.

In commenting on these otherwise excellent precepts, the writer feels that there is too much insistence on the idea of reinforcement for the smaller units. In the British Army, at least, the experiences of the battlefield have been so bitter that they have inspired us with a horror of that dreadful phrase "building up the firing line." We have learnt at an awful cost the futility of crowding more men in

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the echelon of fire which simply resulted in putting forward men's bodies to stop bullets, without any gain. Manœuvre, not reinforcement, is our password even in the case of platoons. Direct reinforcement does not produce so great a moral effect as a diversion from a flank, either on the enemy or the troops reinforced, whilst it allows the fresh troops to catch the infection of discouragement from those whom they reinforce.

It seems fallacious to suggest that the section (platoon) commanders do not need a reserve. Against a resistance distributed in little posts there are many opportunities for infiltration and outflanking for which a "section" reserve is needed.

The fourth purpose of the reserve is worthy of note. Infantry who are well led will forget self, will risk the sacrifice of their own lives by advancing to close with the enemy, but only so long as they feel that other troops are coming on to back them up. It is the feeling of isolation which undermines *morale*. Man, if he sinks self in forming a part of a team, wants to feel sure that the rest of the team will do their share, not leave him to bear the brunt alone; that, when he has spent himself to make an opening, the others will relieve him of the burden. Every group should be able to see near at hand another unit in support. Better still, let this body support him by diverting the enemy's attention in another direction. The sentence "every unit ought to pursue its effort to the full limit of its offensive capacity" is even more weighty. In battle the only true objective is the enemy. It is a direct violation of economy of force to limit the advance of unexhausted units which can find soft spots and can press on with little opposition. The companies and smaller units should press on to gain the battalion objective, their objective being the only true one—the enemy, wherever they find him in their path. It is no longer necessary to advocate this reform against the opposition of the limited objective, as since *Infantry Training*, 1921, has been published it is now authoritative (compare section 36, para. 25, and section 37, para. 8).

The French Regulation continues: "when the objective has been gained, the infantry clears it of the enemy, occupies it, organizes it, consolidates it and maintains contact with the enemy in the direction assigned. The exploitation of success takes the form of fresh combats of reconnaissance if the enemy retires in good order, or if he retires in disorder pursuit without respite aiming at his complete disorganization and capitulation."

The Regulation goes into little detail, however, and, in fact, rather neglects the subject. The pursuit is apparently to be carried out by the troops who have just gained the objective. The writer has always contended that, if the troops who carried out the assault have to be reorganized for pursuit, an inevitable delay will

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occur, as also if a separate battalion under a different commander is used. Hence, a fresh body, but one which is under the control of the commander who has captured the objective, should be used for pursuit. For this purpose the battalion reserve should be used. It should continue to press the advance until fast-moving troops of another arm, or else another battalion, has caught up and passed through it to carry on the pursuit. In this way a relentless pressure on the yielding enemy will be maintained so that his retreat may rapidly spread and gain momentum. (Compare also *Infantry Training*, 1921, Section 35, para. 10, iii.)

TITRE II.—THE OFFENSIVE COMBAT.

The general principles are almost wholly admirable, coinciding largely with those on which *Infantry Training*, 1921, is based. In one paragraph, however, it is laid down that the assault cannot be made until superiority of fire has been gained. This smacks of the pre-war idea of a general fire fight from a definite halting-place preceding a general assault. A temporary slackening of fire from the enemy *points d'appui* may come from many causes besides the actual fire of the attacking infantry.

The artillery fire, the intervention of a tank, or the use of smoke may afford the opportunity for the small local assaults which are characteristic of modern battle. Would it not be better to say that "the enemy's fire must be temporarily subdued." In the report the correct idea was instilled.

It is to be regretted that the Regulation does not emphasize the fact that the security of the small infantry unit in battle rests in particular in a protective formation being adopted. The danger of local surprise, by fire or counter-attack, is ever present during battle. An open formation in diamond or in two echelons which ensures security is therefore as vital for the small unit during the attack as it is for the larger unit during the approach.

The new French organization of command places an officer, the *Infanterie Divisionnaire*, in charge of all the infantry of the division, responsible to the divisional commander. This idea appeals to one as being very sound. It relieves the divisional commander of the multiple responsibility which is his in the British Army. In the opinion of the writer it is too much for one commander to deal directly with three brigades of infantry as well as with the artillery and the other services.

THE BATTALION IN ATTACK.

The ordinary rifle companies carry out the attack. The duty of the other elements is to reinforce their fire and generally to support

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them. The companies are rarely allotted definite zones of action. It suffices to give them points of direction and successive objectives. Then they can pass their reserves through gaps made by the neighbouring units. The formation of approach is usually *lozenge*, or as we should term it, *diamond* (compare *Infantry Training*, Section 18, para. 4, and lectures), with one company leading, reinforced by some machine-guns. The two other companies form a second echelon flanking the first. The bulk of the machine-gun company follows in rear as a third echelon. When the front to clear and cover is unduly broad, the battalion advances in *double column*. A normal frontage for the battalion in the approach is 1,000 metres, and a depth of 1,500 metres. The attack formation will normally be two companies forward and one in reserve. The machine-gun and the accompanying weapon sections will be with one or the other echelon, or behind the reserve, according to their tactical mission. The reserve company will move either in the centre of the battalion sector or on one of the flanks, if it is desired to use a covered approach, guard a flank, or be ready for manœuvre against a weak point. The frontage allotted to a battalion will vary from 300 metres, against a well organized position, to 800 metres. If the frontage is narrow, the ground flat and bare, or if the resistance is likely to be weak, only one company may be forward. The Regulation gives sound reasons for using the reserve for manœuvre instead of direct reinforcement. It is difficult to understand why these reasons should not also apply to the use of the company and section reserve.

The writer regards the frontages mentioned as too narrow, in view of the lessons of the late war. Where the enemy are strongly organized it is useless to increase the density of the attackers. Increased casualties without any compensating gain are the only result. Highly organized defences must be countered by an increase of artillery and tanks, not by reducing the frontage of the infantry units. (Compare *Infantry Training*, Section 39, para. 2, and lectures).

The Company in Attack.

As in the case of the battalion, the approach formation will normally be *diamond* (*Fig.* 10). The elements of the leading section acting as point can be pushed 300 metres ahead of the other sections. *Double column* (*Fig.* 11) is suitable for a wide frontage or ground which is difficult to explore. When the company is reduced to three sections a *triangle* formation is used. A *triangle* formation with three sections forward and one in reserve is suitable when the frontage is exceptionally wide or a great power of fire is likely to be needed at the start of the action. (Compare *Infantry Training*, Section 37, para. 2, and lectures.)

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The attack formation is normally in two echelons, the *echelon of fire* and the *echelon of reserve*. The number of sections allotted to the echelon of fire will be based on whatever strength in automatic rifles the company commander judges necessary to obtain superiority of fire on the whole of his front. On a narrow front and against a weak enemy one section will be in the *echelon of fire* and three in *reserve* (*Fig.* 12). In the normal case two sections will be in the *echelon of fire* and two in *reserve* (*Fig.* 13). In the absence of tanks, when infantry ought to obtain superiority of fire without waiting for artillery support, three sections should be disposed in the *echelon of fire*. (Compare *Infantry Training*, Section 37, para. 2, and lectures.) The frontage allotted to a company will be about two hundred metres. The company commander will gradually fuse his two echelons into one as casualties increase, in order to maintain the force of the attack.

It rests with the battalion commander to judge whether he ought to reinforce the company or replace it with another unit.

The writer is of opinion that a company numbering 160 men is too strong to advance on a 200-metres frontage against modern fire from organized positions. A few groups are quite as effective in exploiting the effects of the artillery fire or tanks without suffering nearly so great losses. As infantry fire power will not suffice to capture such positions, it is best to expose as few men as possible in following up the advantage gained by other arms.

We see here again, in the case of the company, that the idea of reinforcement is put before the idea of manœuvre. Surely this is unsound doctrine. Throughout the Regulation there is scarcely any insistence on the use of penetration and outflanking, or explanations as to how it should be carried out. The formations laid down for companies in the second and third echelon are *diamond*, *double column* (*square*), *chequer* and *trapeze* (*Fig.* 14), to guard flanks, *triangle*, or *in echelon with one flank leading* in order to cover an exposed flank or connect two units which have made unequal progress (*Fig.* 15). The commander always moves at the head of his unit if it is in the rear echelons.

THE SECTION IN ATTACK.

The 150-metres frontage of the French section in the approach may be compared with 200–300 metres allotted even in the attack to the English platoon, which is smaller. For the approach the section commander disposes his three groups *in succession*, *abreast*, or *in triangle*, according to the frontage to be covered. The formation with groups *in succession* is the easiest to lead through woods, at night, or to take advantage of a covered approach (bottom, *Fig.* 10).

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The formation by groups roughly *abreast* at 25-metre intervals is the least vulnerable to shell or distant machine-gun fire (top, *Fig.* 11). The *triangle* most nearly reconciles both needs and leaves a reserve in hand (bottom left, *Fig.* 11).

In attack the *triangle* formation with two groups forward is normal (top right, *Fig.* 13). The formation with all three groups abreast is in practice little different, because of the fluctuations of the pace caused by ground or fire (top, *Fig.* 12). It is suitable when the full fire power of the section is needed at once, or when the section is closed up to avoid the enemy's barrage in a position warfare attack.

The Group in Attack.

The rôle of fire is fulfilled in particular by the automatic rifle *équipe* and the rôle of movement and protection by the rifle *équipe*. During the approach the group advances generally by large bounds, carried out by the group as a whole. It is made in *column by one* or *by two*, or even deployed by *équipes* in *column by one* (*single file*). When the aim is to make contact with the enemy, the leading groups act as patrols, with the rifle *équipe* at the head. In the other groups the automatic rifle *équipe* leads, ready to open fire if an engagement occurs unexpectedly. In attack there is no normal formation for the group. Any disposition can be adopted or altered according to the needs of the moment. Deployment in skirmishers in either one or two ranks is recommended as most suitable in a trench attack or behind a rolling barrage. In the *équipes* themselves the disposition of the men depends on their functions; in the case of the automatic riflemen, to best serve the gun; in the case of the rifle *équipe* the men are more or less together or dispersed, with the two grenadiers acting as riflemen, unless they are told off to use their special weapons.

The sole essentials in every case are:—

(i) To rally always to the group leader.

(ii) To move at least at the intervals indicated in order to reduce the target; to avoid collecting save behind good cover.

(iii) For men who are ahead of the automatic rifle, to avoid masking its fire.

Normally the manœuvre necessary to take any centre of resistance will be carried out by several groups. On the other hand, the division of the group into two *équipes* makes it capable in some degree of itself exploiting by movement the effects of its fire. The two *équipes* co-operate at all times to the common advantage. Generally the rifle *équipe* exploits by movement the effect of the automatic

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rifle's fire ; though sometimes the latter *équipe* will itself exploit this effect and progress without waiting for the riflemen. At another time the rifle *équipe* can produce by a sudden concentrated fire a similar effect, to the profit of the rest of the group. In other cases this exploitation will not result from the action of the group itself, but from that of another group. Save when their personal security is at stake, or when they have every chance of knocking out one of the enemy who offers a good target, the men of the group never fight on their own, but always as a team for the attainment of the common mission.

THE DEFENCE OF THE GROUND.

The general principles of the defensive combat are wholely admirable and are expressed with the clarity of expression which is peculiar to the French genius. They are, however, so nearly similar to our own doctrine that it is unnecessary to dilate upon them.

The troops of the defence are divided into :—

(i) The troops for security, or outposts, who fight on the position of security.

(ii) The *gros* or main body, who defend to the finish the principal position of resistance.

(iii) The general reserve, placed on the barrage position and in rear.

Great importance is attached to the detailed preparation and rehearsal of all possible moves beforehand to meet an attack when it comes. It is excellent to note how the interchangeability of the rôles of attack and defence is constantly stressed.

One is struck by the omission of any reference to the use of observation posts by infantry units. Surely these are of great value in enabling commanders of rear echelons to keep watch on the situation in front. Sections or companies detailed for immediate counter-attack are thus enabled to intervene at the right moment. Turning next to the question of outposts, divided into an *echelon of surveillance*, an *echelon of combat* and an *echelon of reserve*, the writer disagrees with the idea put forth that the posts of the *echelon of surveillance* should fall back. He contends that actual experience proves that these posts cannot disentangle themselves and retire on the echelon behind without causing confusion, particularly in the dark. Troops who retire from any position which they have taken up must rally and reorganize behind another position of defence before they are in a condition to offer any effective resistance. When it is desired that the *echelon of surveillance* should fall back they should

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be composed of patrols, not of fixed posts. Such an arrangement maintains the idea that infantry who have consolidated posts should not retire. Posts are likely to hold on too long and so mask the fire and confuse the resistance of the echelon in rear when they fall back.

The writer finds in the part dealing with the dispositions in defence a similar idea to his "contracting funnel" method of defence. Just as manœuvre from a flank is far superior to frontal attack in its moral effect, so manœuvre fire which enfilades the enemy is the most damaging to the attackers' morale, and also in its material effect. It represents the principle of surprise. Thus the aim should be to dispose the posts of the defence so that the attacking enemy is encouraged to penetrate into channels in which he can be raked by flanking fire. A means to this end is to place the posts of the reserve echelon on the flanks of the natural channel of approach to form gradually contracting funnels. Thus, the further the attacker penetrates the more resistance he encounters and the more confined becomes the space in which he can manœuvre. (Compare also *Infantry Training*, Section 44, para. 2.)

In the prescriptions of the French Regulation upon the use of the reserve, it is curious that they place more reliance on stationary fire and less on counter-attacks than we do.

The writer regards as unsound the doctrine set forth in the Regulation that the reserves should be distributed over the ground in groups and sections and occupy posts. If a counter-attack is to be successful it must be immediate, and to collect the infantry groups from these posts will surely take too long and so allow the right moment to pass. He considers it better that they should consolidate section (platoon) posts, preferably on a flank, and then be consolidated near by. Then, if the enemy break through the forward position quickly and on a broad front, they can occupy their position and take him in flank by fire; otherwise they can deliver an immediate counter-attack to throw him out of the lodgment he has made, or manœuvre to close the flanks of the breach by fire from temporary positions. The writer advocates that the battalion should be distributed in three echelons, a *forward echelon of resistance*, a *counter-attack echelon* which can occupy its position if advisable, and lastly, a *final echelon of resistance* in case the counter-attack fails. This last will serve as a rallying place. If the forward and counter-attack echelons fail to fix and break up the enemy attack, it will be the duty of the rear echelons to fix him in order to allow the superior unit to decisively manœuvre against him. (Compare *Infantry Training*, Section 36, para. 31, and Section 48.)

In summing up his impressions, the writer would direct his main criticisms against the doctrine of the all-importance of the automatic

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rifle in the fighting unit of infantry; against the retention and insistence in the idea of reinforcement; against the lack of attention paid to the subject of manœuvre; finally, against the undue repetition which tends to confuse the reader and occasionally leads to one paragraph contradicting another. The writer's special admiration is rendered to the supple and simple drill formations, to the soundness of the underlying principles, and to the crisp and easily understandable manner in which the whole Regulation is written and illustrated.

January, 1922.

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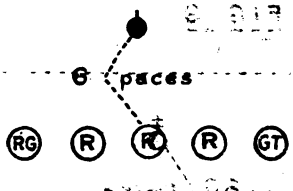
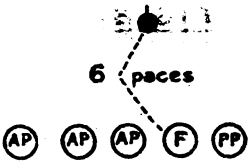
FIG. 1.



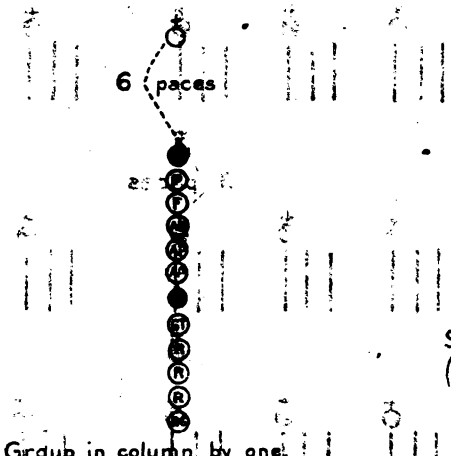
Equipe of riflemen (voltigeurs) in line of one rank.

FIG. 2.



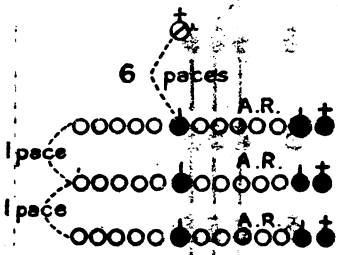
Equipe of automatic riflemen (fusiliers) in line of one rank.

FIG. 3.



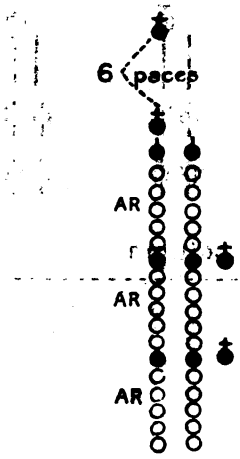
Group in column by one.

FIG. 4.



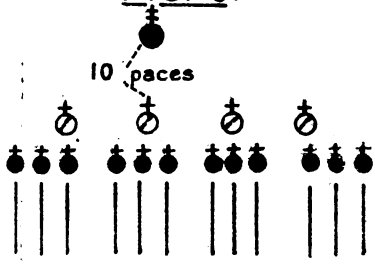
Section in line on three ranks (on command Right turn section is in column by three)

FIG. 5.



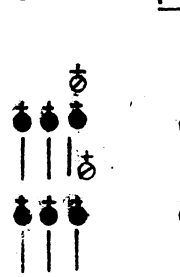
Section in column by two.

FIG. 6.



Company in line of sections by three.

FIG. 7.



Company in double column.

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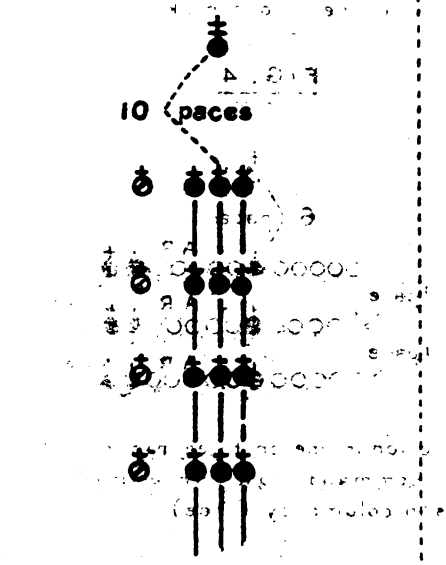
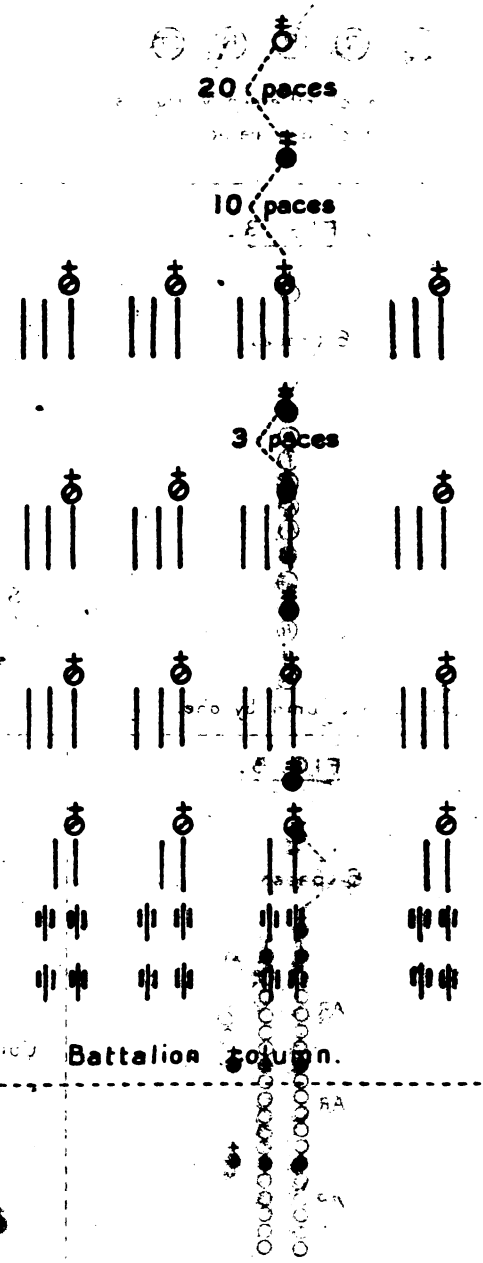
FIG. 8.



Company in column by three.

FIG. 9.



Battalion column.

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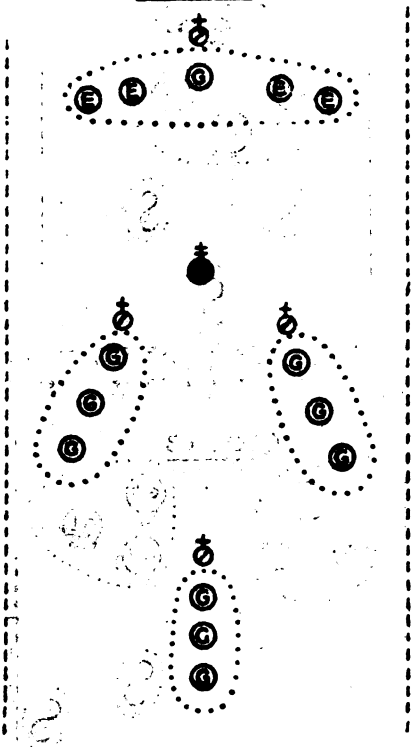
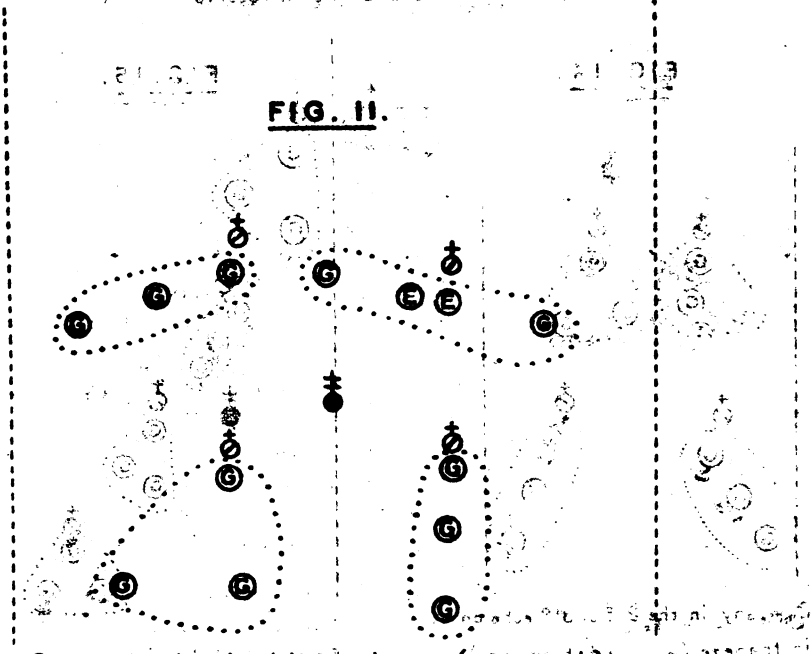
FIG. 10.



Company in Lozenge (approach)

FIG. 11.



Company in double column (approach)

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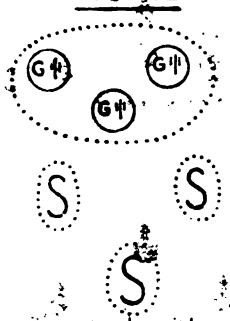
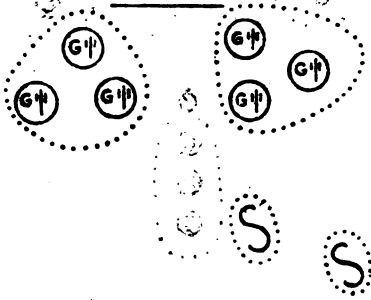
FIG. 12.



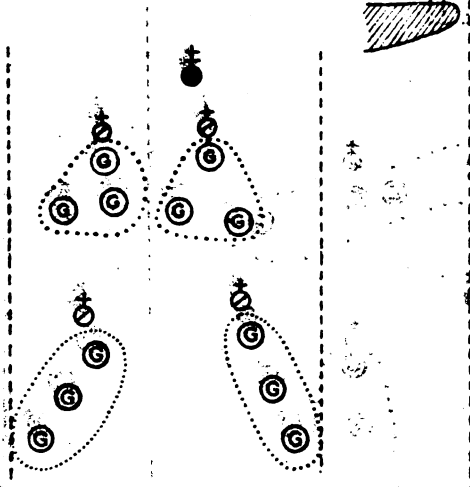
Company in attack with one section in echelon of fire and three in reserve.

FIG. 13.



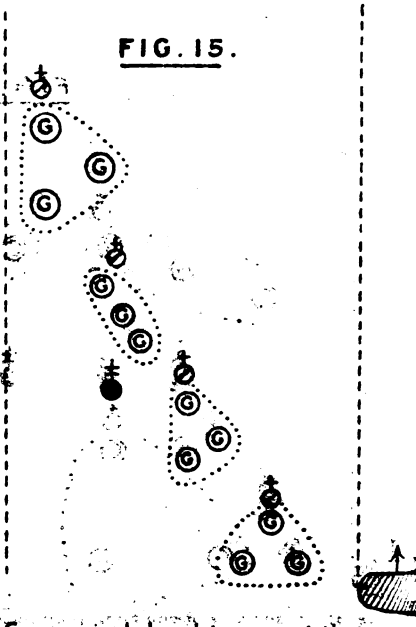
Company in attack with two sections in echelon of fire and two in reserve

FIG. 14.



Company in the 2nd or 3rd echelon in trapeze (approach formation)

FIG. 15.



Company echeloned to connect the two neighbouring who have made unequal progress

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*THE FALL OF NOVO-GEORGIEVSK.**

As in the case of Antwerp and Maubeuge, there are now accounts of the attack and defence of the old Russian fortress of N.G. from both belligerents. From the German side there is the recently published official account ;† and from the Russian the book of General Basil Gourko, ex-Chief of the Russian Imperial General Staff.‡

The German account is well got up with maps and photographs, like the Antwerp volume ; but, unlike it, it is a vain-glorious and popular account of little military value—at any rate, engineer military value : it is full of stories of individual acts of daring, but does not contain any description of the fortress or its defences.

The photographs, except for one view of concrete casemates under a parados, show the older inner forts, built in the 'sixties. Perhaps the reason for this is that the so-called forts were hopelessly out of date, built in the 'eighties, after the Russo-Turkish War, and at best only of the Twydale-redoubt pattern, subsequently favoured by Lord Sydenham and, even with acres of wire entanglement, not storm-proof.

N. G. stands at the junction of the Narev with the Vistula, and, with Warsaw and Zegrgie, it once composed the so-called " Polish fortified triangle." After the Manchurian War proposals were put forward to reconstruct these fortresses and bring them up to modern requirements—to form a great *Feste*, on the German model, and N. G. was to have had a new belt of forts. In a characteristic Russian fashion, operations were commenced by destroying the existing forts of Warsaw and Zegrgie ; and it was in this state that the War found these two fortresses, whilst N. G. was exactly as it was in 1891. How far the story is true I do not know, but I was told in Warsaw in that year that, in the lay-out of N. G., the town of Modlin, at the junction of the rivers, was destroyed, its inhabitants removed, and the citadel built in its site. It is, however, borne out by the German map, which shows a closed enceinte, marked N. G., only about 2,000 yards across, with the citadel inside, and no town whatever. The outer line of defence, the redoubts, or forts, as the German

* The name is shortened to N.G. throughout this account.

† " Die Eroberung von N.G." Herausgegeben unter Mitwirkung des Reichsarchivs (Oldenburg, Stalling, 25 Marks).

‡ " Memoirs and Impressions of War and Revolution in Russia, 1914–1917 " (London, Murray, 18s.).

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account calls them, was from 5,000 to 7,000 yards from the citadel, and inside it was a belt of older forts, about 3,000 yards from the central point. The country is flat, marshy and thickly wooded.

General Gourko states that in 1914, the "greater part of the garrison consisted of militia brigades, which, at the commencement of the War, were utilized solely for the construction of field positions. It was only a short time before the surrounding of N. G. that they were used for operations in the field. The militia was made up either of older men, or of men who had not served the usual three years in the Army, having been exempt on account of family reasons." The officers were elderly men, taken from the Reserve. The brigades were organized as two infantry divisions, and the Commandant of the fortress was a cavalry officer.

The general advance of the German-Austrian Armies in the great offensive of 1915 brought them in July level with N. G. A force, under General von Beseler (lately dead, an engineer officer, in 1908 Inspector-General of Engineers and Fortresses), who had commanded at Antwerp, was detailed to invest the fortress and capture it as soon as possible. This force consisted of improvised formations, mostly *Landwehr* and *Landsturm :*

Dickhuth-Harrach's Corps : Composed of 18 battalions, 15 machine-gun companies, 4 squadrons, 19 batteries of various calibres, 2 engineer companies, etc. ;

Pfeil's Mixed Brigade : 14 battalions, 1 machine-gun company, 1 squadron, 7 batteries, 2 engineer companies, etc. ;

14*th Landwehr Division* : 9 battalions, 5 machine-gun companies, 1 squadron, 16 batteries, 1 engineer company, etc. ;

169*th Landwehr Brigade* : 6 battalions, 2 machine-gun companies, 1 squadron, 3 batteries, 3 engineer companies ;

Westernhagen's Group : 11 battalions, 5 machine-gun companies, 1 squadron, 8 batteries, 2 engineer companies, etc.

Some 80,000 fighting-men in all.

Of "heaviest artillery" there were five 16-in., nine 12-in. howitzers, and one high velocity 5·9 in. gun : of heavy artillery, 45 8-in. howitzers, eight 8-in. mortars, four 5·9-in. guns, and twelve 4·8-in. guns, besides two 9-in. trench-mortar companies. For observation, there were two balloon sections and one aeroplane squadron.

The Germans, at the very start, had an extraordinary piece of good luck : as the advanced guard approached N. G., the Chief Engineer of the fortress and his staff officer—whilst reconnoitring with all the plans of the defence—ran into a patrol in his motor-car, and was captured.

Leaving a screen only on the western side of N. G., the investing force extended first north and north-eastwards, and then south-

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ward of it, thus acting as flank guard on the sides of the fortress for the advancing armies. The northern party had fighting on the 26th July with rear guards of the main Russian Army, but the southern did not make much progress until Warsaw was evacuated on the 5th August. There was also some delay in closing round the eastern side, owing to three old barrier forts near the Narev, some ten miles east of N. G. having to be captured, for which purpose heavy artillery had to be brought up; but on the 10th August the investment was complete, the garrison having made no attempt to interfere.

General von Beseler, for railway transport reasons, decided to attack from the north-east (Forts XIV-A, B and C; XV-A and B; and XVI-A and B) and to follow the same policy as at Antwerp, *viz.*, to concentrate artillery-fire on a narrow sector of the defences and destroy them, then to widen the gap, and, as soon as possible, to assault. There was, we are told, only sufficient ammunition for two and a half or three hours' preparation; and reliance was placed on the great moral effect of the 16-in. and 12-in. howitzers.

The old Russian Militia, however, had been busy, and had constructed a field position outside the line of the forts and erected a considerable amount of wire, and this position had to be dealt with first.

It was intended to commence the artillery attack on the field position at 4 a.m. on the 13th August, but heavy fog prevented the opening of fire until 9.30 a.m. After three hours' shelling, at 12.30 p.m., the assault, on a front of six miles, took place and the position was captured.

The artillery was now concentrated on Forts XV-A, XV-B, XVI-A and B, and the field-works between them. The amount of ammunition fired is not given, as it was in the case of Antwerp, but the bombardment was continued during the 14th and 15th August, and an assault was attempted on the 16th. Forts XV-A and B were eventually captured, six battalions being used against the former and seven against the latter; but the assaults made on Fort XVI-A by eleven battalions, and on Fort XVI-B by one battalion, failed. On the morning of the 17th the Russians from the woods behind are said to have made a counter-attack against XV-A; but during the night of the 17th–18th they evacuated not only the Forts on the front attacked from XIV to XVI, but all the outer ones on the north side of the rivers, and these were occupied by the Germans.

During the 18th and 19th, the Germans closed in nearer the fortress, right up to the inner forts, of which Nos. II and III were entered without opposition.

The unconditional capitulation was signed at 4 a.m. on the 20th August, thirty days after the appearance of the Germans before the

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place, and ten days after the completion of the investment. Ninety thousand Russians, with thirty generals, became prisoners.

The only lesson of the siege appears to be that, as at Antwerp and Maubeuge, an obstinate defence cannot be expected from second-class troops, " bearded men, who went into action with pale faces, thinking of their wives and families." General Gourko states that the spirit of the garrison was broken by the bombardment and the men were not fit to offer any real resistance to the storming columns. No attempt was made to delay the process of investment, or to make retrenchments at the place attacked.

J. E. E.

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SOME ASPECTS OF THE LEAGUE OF NATIONS.

A Lecture delivered at the S.M.E., Chatham, on 27th October, 1921, *by* LIEUT.-COLONEL H. O. MANCE, C.B., C.M.G., D.S.O.

THE object of this lecture is not propaganda. I propose rather to try and put before you certain aspects of the League of Nations in such a way that you can think it out for yourselves and arrive at your own conclusions. The subject is obviously too wide to be covered in one lecture. I might begin by recounting the activities of the League and deduce from these what the League really means. I propose, however, to begin with a general consideration of what the League is and how it will work, after which, I hope, you will have no difficulty in following its achievements for yourselves.

What is the League of Nations? Let us take a hurried glance through the Covenant. The Preamble is most important, as it enunciates the object of the League, which is "to promote international co-operation and to achieve international peace and security by the acceptance of obligations not to resort to war, by the prescription of open, just and honourable relations between nations, by the firm establishment of the understandings of international law as the actual rule of conduct among Governments, and by the maintenance of justice and a scrupulous respect for all treaty obligations in the dealings of organized peoples with one another."

Articles 1 to 7 describe the organization of the League, consisting of the Assembly, the Council and the Secretariat, and its general constitution.

Articles 8 and 9 deal with the question of disarmament.

Article 10 is the famous article which primarily caused America to stand out of the League. In it the members of the League undertake to respect and preserve as against external aggression, the territorial integrity and existing political independence of all the Members of the League.

Articles 11 to 15 deal with the avoidance of war and procedure for disputes.

Article 16 refers to the action of the League against defaulters.

Article 17 deals with disputes with non-members.

Article 18 prescribes the registration of Treaties before they become binding.

Article 19 deserves more consideration than is generally given to it. It provides for the reconsideration of obsolete Treaties and international conditions likely to endanger peace.

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Article 20 cancels all existing obligations contrary to the Covenant
Article 21 permits of regional understandings.
Article 22 deals with Mandates.
Articles 23 to 25 deal with the technical and humanitarian objects of the League, and Article 26 lays down the procedure for amendments.

Supposing, however, that the Covenant has been carefully studied, is this sufficient to indicate the nature of the League of Nations? If you wanted to study medicine you would not be satisfied with studying the Rules of the British Medical Association. If you want to understand what is the League of Nations you will be liable to get a superficial idea by studying only its Articles of Association.

Who then is to say what the League of Nations really is? Even the experts on the subject present widely different conceptions, depending upon their personal outlook and antecedents. Some talk of idealism. This is the easiest, as it usually goes down well and does not require much hard thinking. Some regard it as an organization for settling political disputes; others concentrate on the juridical aspect with special reference to the Permanent Court of International Justice. Others regard it as an organ for effecting disarmament; others as a machinery for international relations; others as a new form of military alliance; others from an economic standpoint, each neglecting other aspects to a greater or lesser extent. In the absence of an orthodox interpretation of the Covenant, let us work out for ourselves some idea of what the League might be. In doing so, we must try to avoid the tendency to present one side of the League to the exclusion of its other aspects, thereby offering an easy target for criticism. There are several sides to any solid structure, so we must be careful not to condemn those who describe the League from a different point of view until we are certain they are not presenting another elevation of the same building. We shall not be able to make even an outline plan until we have had a careful look round, and we must all discard any notion of infallibility and be prepared to modify our design as we gain further experience. I will try to approach the subject primarily from the point of view of the man in the street.

It is quite possible for anyone to examine this question to a considerable degree without any exclusive information. I hope, in addition, to suggest a few ideas based on an inside knowledge of the League which may help you to assimilate the quite reliable information regarding the League which appears in certain sections of the Press.

In dealing with so complex a question it is indispensable to start with principles and tendencies; principles to make clear the goal aimed at and tendencies in order to ascertain whether world forces are operating in favour of or against the prospects of the League.

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We shall be helped also in this way to keep in touch with realities. The Covenant owes its origin to world reaction against war. When attending the first Assembly of the League of Nations, I was very much struck with the general anxiety to arrive at an agreement and to achieve something, and I formed the impression that the driving force at this Assembly was the general fear of another war. It is important to consider whether the conditions are favourable for the League to survive the disruptive forces of national interests and sentiment once the initial impulse is exhausted. First let us consider what driving forces may operate when the immediate fear of another war recedes into the background. I suppose one might generalize these forces into the alternatives of idealism and self-interest. No big thing is done in this world without an element of idealism, and the League of Nations is no exception to the rule. But we may suppose that our man in the street maintains that the strongest incentive to action in the present state of human nature is self-interest, and that no League will succeed which does not take account of that fact. Very well, let us deal with the subject from the point of view of self-interest.

What is the object of the League? To stop war? Too late. To prevent war? Yes, but how? By arbitration? This implies disputes. Surely it would be better to prevent disputes. Thus we are led to the chief object of the League being the regulation of international affairs. What is the nature of the League organization? Certainly not a super-state. No Power, great or small, is prepared to delegate any of its sovereign powers to the League. It follows, therefore, that the organization must work through free co-operation between sovereign states, and this, in its turn, implies unanimity for any decision which is to be obligatory on all the members. In such questions large and small powers may be said to be on a basis of equality, but it is evident that where the League is to take executive action—for example, in solving a dangerous political situation—the assent of the powers on whom would fall the chief responsibility for ensuring the execution of the decisions of the League must be arranged for. Hence, the principal powers would occupy a position corresponding to the senior partners of a business. It is important to note that the League of Nations is a League of States and not of individuals.

The first question which will probably be asked is: In what way does the above organization operate differently from pre-war methods of international relations? Perhaps the most important difference is that the League is intended to be guided by principles common to all its members, whereas, before the war, international questions were settled directly between pairs or groups of nations directly interested, without any reference to the solutions adopted elsewhere in similar matters. Is it possible, however, to arrive at common principles,

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having regard to the different ethical traditions prevailing in different countries, or even to different religions? I think it must be admitted that common principles are, to a certain extent, implied by the very fact of international relations. They certainly existed in certain directions before the war, and experience has shown that they can be expanded by frank discussion and closer contact. During such discussions between a sufficiently large number of independent representatives, a sort of public opinion gradually develops and helps in the formation of these common principles. Such public opinion was distinctly noticeable at the two Assemblies of the League of Nations at Geneva, and at the Communications General Conference held at Barcelona in March, 1921. The collective handling of these questions encourages a tendency to crystallize common principles into international law through such instruments as general conventions. It is important to recognize that these conventions are not an idealistic conception of abstract principles, but are the simplest common expression of the interests of each of the contracting parties.

Now the codification of these common principles facilitates arbitration or international jurisdiction. Without such a code States hesitate to entrust to arbitration questions which might have some unexpected bearing on their sovereign powers, but it is quite a different matter when the dispute is simplified to the interpretation of a convention to which the parties to a difference are signatories. Conversely, an interpretative organization, whether for conciliation, arbitration or jurisdiction, gets over the necessity for drawing up a code which tries to deal with every possible case, and which is, for that reason, unworkable. It is evidently much easier to draw up a code indicating clearly what is the general intention of the framers, if there is an organization to which the signatories are prepared to confide the interpretation of the code in any particular case which may not be explicitly referred to.

Now let us see if we can get any hints from methods of inter-Allied co-operation during the war, more particularly in the economic sphere. Here we note a very important development, namely the practice of discussions between the respective experts of different nations before the national policy of any one of them is fixed. During the war these discussions, on such questions as the allocation of allied shipping, raw materials, etc., were informal and non-binding, but it is significant to note that the agreements arrived at were invariably confirmed at the Plenary Conferences. It is true that direct contact and personal touch have played an important part in the past in arriving at international agreements, but the significant fact has been that after this touch was lost the force of the agreements tended correspondingly to diminish. Not the least important of the functions of the League of Nations is the maintenance of the continuity of touch between representatives of the various nations. It is

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surprising how long it takes a freshly convened international conference to arrive at a common understanding of the many different points of view involved, and at a sufficiently intimate knowledge of the personalities of the representatives, to enable the basis of a general agreement to be discovered. Unless the different points of view are thoroughly understood, there is danger that any agreement arrived at may be unstable. This difficulty is virtually eliminated by the institution of a permanent organization, the members of which change gradually. Before the war, negotiations affecting technical departments in two states had to travel from the head of the technical department in one state, through the Foreign Office, to the Ambassador in the capital of the other state, through him to the Foreign Office of the other state, who communicated with the head of the technical department in that state, the original communication having been redrafted two or three times in the process. It is hardly necessary to draw attention to the relative advantage of direct personal intercourse between the respective heads of departments of the different states. Finally, the League of Nations possesses the means of convening Conferences for dealing with any particular question at comparatively short notice, as compared with the years that were usually necessary under pre-war conditions. So far, we have envisaged a League of Nations which is a partnership of states for the regulation of international affairs, each state retaining its full independence. An important feature of the organization is the continuity of personal touch between the representatives of the different states, this continuity being maintained both by the permanent organizations and by periodical conferences. The resulting tendency is to codify common principles, thus leading to an increased recourse to arbitration and international jurisdiction, the whole being assisted by the gradual development of a world public opinion. At this stage we can perhaps mark, as one of the essential common principles, that secret understandings between individual nations or groups of nations are bad form. There may be expected an increasing tendency to publicity in dealing with international questions.

I have already referred to the influence of world public opinion in bringing about general agreement in the codifying of common principles affecting international relations. The existence of the League depends on the formation of a world opinion on international questions. The very fact of propaganda in neutral countries during the war is a tribute to the increasing power of world public opinion and recent instances will occur to you when big, as well as small powers, have been influenced by world public opinion in their action, not only in international but in national questions. Incidentally, parties to a dispute are more likely to give way to the decisions of an impartial body representing world public

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opinion than to arguments between each other where their *amour propre* is at stake. World opinion in the League of Nations is shaped by the representatives of its Members. It must, however, ultimately reflect the public opinion of each country. National opinion was previously based on purely national sources of information. Now, however, many questions which were previously national are becoming international, and there is a corresponding demand for information on a wider basis. The improvement of communications, especially as regards wireless telegraphy and telephony, has resulted in the opinions held in other countries being published at first hand, instead of almost invariably through national correspondents, and it seems obvious that this tendency will increase.

During the war the common danger of the Allies led to the subordination of national interests to the common cause. Since the Armistice this subordination of national interests has depended on the degree to which the common interest has been recognized in different emergencies. The question is, will the other extreme ever occur, and the disappearance of common interests lead to exclusively national policies? In spite of the recent outbursts of national Jingoism in various countries it is difficult to imagine a return to pre-war national exclusiveness. On the contrary, the gradual realization of the danger of common economic collapse will speed up the business of thinking internationally and give an impetus to the codification of principles essential to the safety and well-being of different peoples. If, ultimately, aggression, wherever it may take place, against these principles is recognized as a common menace, then automatically states will combine to bring the pressure of public opinion, and, if necessary, of force, against such aggression, which is as they have bound themselves to act in the Covenant.

Similarly, in the case of disarmament, I would suggest that the stipulations of the Covenant are more likely to eventuate as a symptom of a successful League of Nations rather than as the means of obtaining such success, though, doubtless, progress will be achieved from both directions. Armament is still necessary in the present conditions as an insurance of national security and interests, but for some years to come we shall have to choose between gradual economic recovery with moderate insurance or increasing armaments and nothing left to protect. This may result in a tendency for a united front against any power which creates a menace of aggression by aiming at military preponderance, and thus, as was the case with individual armament, will national armaments automatically be reduced in proportion to confidence in the League to resist aggression. It may be asked what will happen to the Balance of Power in which we have hitherto placed confidence for the maintenance of peace. In this connection I would refer you to an interesting article by Sir Frederick Maurice, who points out that, while the Balance of Power

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was a working proposition in the days of limited armies, it has become an impossible burden now-a-days when the whole resources of a nation would have to be organized for the conflict. Personally I am not quite sure that the military side of the League of Nations is not the modern development of the Balance of Power, in that it seeks to avoid this crushing burden of armament by establishing an overwhelming preponderance against any disturbers of the peace.

As time goes on, some nations will inevitably grow in power and influence and others gradually become less important, and it may be asked how the League of Nations would deal with the adjustment of political power necessary to correspond with such changes. Under the old regime, the transfer of power took place as a result of war. The problem is a fundamental one for any organization for the maintenance of peace. If these adjustments are to be made on the old basis of the transfer of territory, the prospects of a peaceful adjustment would seem to be very unpromising. It is evident, however, that the magnitude of the problem would be considerably reduced if security, freedom and economic policy could be to a large extent divorced from territorial sovereignty, and this idea is one of the underlying motives of certain important aspects of the Peace Treaties, such as the Mandatory system, the clauses for the protection of minorities and the stipulations regarding the freedom of transit and communications and the equitable treatment of commerce. The transfer of sovereign powers or special privileges as regards territories disposed of at the Peace Conference was, as a general rule, made subject to the acceptance of certain international obligations to conform with generally accepted standards on questions of communications, the equitable treatment of commerce and the protection of minorities. The extension of this principle in the future is a desirable development and one not unlikely to be adopted as it would seem to be supported by the whole gamut of motives, from the highest idealism to the rankest jealousy. The net result, however, would be to facilitate the general adoption of recognized standards of equality of opportunity and to reduce the possible causes of friction due to the continued existence of frontiers. But what if the homeland is threatened by the penetration of a more virile or more favoured nation? There is no justification for assuming that the collectivity of nations will not continue to recognize the fundamental right of self-preservation by reasonable local measures. Ultimately, the growing recognition of the common interest in maintaining peace will be the principal force tending to prevent the inevitable adjustment taking place through war. I have already drawn your attention to Article 19 of the Covenant under which the Assembly of the League may from time to time advise the reconsideration by members of the League of treaties which have become inapplicable and the con-

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sideration of international conditions whose continuance might endanger the peace of the world.

Now there is another aspect of the question. Out of deference to a hypothetical man in the street I have hitherto dealt with the League on the basis of self-interest, leaving aside the influence of idealism. It may now be confessed that this was the easiest way to handle the question, for, in other words, I have appealed to reason instead of to sentiment, and with reason one knows more or less where one stands and can build up on generally agreed facts. Unfortunately, however, there are occasions on which the actions of nations are governed less by reason than by sentiment, and in some countries it is to be feared that this is the rule rather than the exception. At the end of 1919 the cynic might have been tempted to divide European civilization into two categories—those states who were bent on furthering their own interests, and those states who were completely indifferent to their own interests, provided they dished the interests of their neighbours. On closer inspection the optimist would detect the elements of progress between these two categories. The question is obviously one of outlook and length of vision. One of the principal factors of progress will be the gradual education of peoples in international questions. What will be of even more importance in the immediate future will be the influence of a few big men of character, especially in the new countries. In this connection, it is hoped that the different states will recognize the undoubted fact that, while every member of the League theoretically participates at the annual Assembly on the basis of equality, those states, big or small, whose delegations are comprised of men of character and vision have had and will have an outstanding influence on the deliberations of that body.

I have ventured to outline above a tentative sketch plan for the gradual building up of a Partnership of nations for the

Regulation of international affairs based on the
Recognition of general principles vital to the security, freedom and well-being of all nations ;
Operating through world opinion,
Favoured by personal contact and frank discussion before the crystallization of national policies,
Tending towards the fixation of principles into international law,
Rendering possible international jurisdiction,
Backed by the increasing assurance of international solidarity against aggression, and
Whose success will be measured by the growth of confidence and gradual reduction of armaments.

Thus one of the principal points to remember would seem to be that any conception of a League of Nations must be of a living organism

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and not of a finished product. All the developments foreshadowed above are bound to take time to mature. The machinery and initial impetus of the League has made a start possible. It is necessary for its success to develop the power behind the machine and to avoid an overload.

I should like to emphasize the fact that nothing I have said implies the destruction of the individuality of nations or races. It is essential that precautions should be taken to prevent the deterioration of national qualities which would result from the indiscriminate mixture of races. Champagne and beer are both excellent beverages, but by mixing them you would lose the good qualities of both, and if you can imagine the addition of bovril and tea you will understand my point.

I trust that the ideas which I have put before you, modified or expanded as the result of your own reflection, will be of assistance in following the development of the League and in interpreting foreign news from a wider standpoint, so that you will be able to recognize where solid progress has been achieved and to appreciate the inherent difficulties of certain situations and the necessity sometimes for going slow.

It may be suggested that the present situation, with at least a dozen separate crises of the first magnitude, is hardly one to inspire undue optimism. I am not sure, however, that this is not a question of diagnosis. A sick man, suffering from undefined pains all over his body, may quite well be passing through a necessary phase towards recovery when the poison in his constitution comes to a head, and the optimist will derive satisfaction from the tendency, which has undoubtedly developed, of calling in the League of Nations to effect a cure. The optimist will further remember that any external application at a particular outbreak may alleviate, but cannot be expected to cure, the patient, and will therefore attach greater importance to the more general remedies directed to curing the sources of the trouble, reinforced by the up-to-date method of suggestion through the force of public opinion. You will recognize, from my previous remarks, that there is always some danger of the patient losing his reason, thereby increasing the difficulty of rational treatment.

I will conclude, as I began this lecture, with a reference to the Covenant of the League. It seems to me that the Covenant may be likened to a roof supported on scaffolding. Under the shelter of this roof nations, spurred to a greater or less degree by the lessons of the great war, are striving to lay the foundations and build the walls of a structure of international co-operation. It behoves reasonable critics to ponder whether they are more likely to help by tinkering with the roof at the present juncture rather than by contributing to the construction of the edifice on which the security of the whole

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depends, trusting to make any necessary alterations to the roof at a more suitable season when this can be done with less risk of interfering with the progress of the work. Whatever conclusions one may arrive at regarding the League of Nations, it must be remembered that no one has hitherto proposed an effective alternative protection from the recurrence of a world war, and, therefore, if our roof, through lack of solid support, should collapse under some great strain, there is every probability that this civilization will be overwhelmed in the ruins.

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ANTI-AIRCRAFT DEFENCE BY NIGHT.

"EVERY commander is, therefore, at all times responsible for protection of his command from surprise in every direction from which attack is possible (both by land and air), and for preventing the enemy from ascertaining his strength and dispositions."—(*Field Service Regulations*, Volume II, Chapter VIII, Section 79, para. 4.)

This article endeavours to state generally the means of defence that are available to the commander of a force for the protection of his command from aerial attack by night.

The defence can be arranged to employ one or all of the undermentioned methods.

1. Anti-aircraft guns firing a barrage.

This can only be effective over a comparatively small area and could not cover at one time all heights from 6,000 ft. to 20,000 ft. In any case, daring pilots will fly through a barrage. For fixed defences it might be adopted in certain cases, such as ground mists, where the supply of ammunition is unlimited.

2. Anti-aircraft guns firing when the hostile aircraft has been illuminated by searchlights.

It can be generally stated that anti-aircraft guns are only really effective in so far as they drive aircraft to a height and affect the pilot's nerves, thus causing the machine to fly on varying courses, and thereby hindering observation and bombing.

3. Machine-guns operating with or without searchlights for low-flying aeroplanes.

Against low-flying aircraft the appropriate weapon is the machine-gun, which is very effective up to heights of 3,000 ft. It has been found that the best position for these guns, which should be two in number, is at the searchlight. One gun should be arranged so as to fire up the beam, and the other reserved for use in case of attack on the searchlight by low-flying aeroplanes not in the beam.

4. Night-flying aeroplane co-operating with searchlights.

Of the above methods the last is undoubtedly the most effective.

The pilot of an aeroplane illuminated by searchlights is blinded by the glare and cannot observe ground objects. Bombing under these conditions is indiscriminate. In addition a hostile aeroplane illuminated by searchlight beams becomes an easy target for a night-fighting aeroplane, which can see the enemy without being seen, and can manœuvre unmolested until a suitable position in

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relation to the hostile machine has been obtained. The hostile machine can then be brought down by machine-gun fire at the pilot's leisure.

The efficiency of the above method of dealing with hostile aeroplanes was proved by the operations of 151 Squadron, R.A.F., co-operating with the 1st, 3rd and 4th Army's Searchlights, France, during the period July—November, 1918. During the first five weeks of this period over 20 hostile machines were brought down and the enemy's night-flying activities were brought to a standstill.

In the article published in the March *R.E. Journal* on "Anti-Aircraft Searchlight Defences," the problem of the anti-aircraft defence appears to have been based on the old-established principles of fighting fixed coast defences, which were not tested at night in action during the late war. The anti-aircraft defence problem is infinitely more complicated, in view of the fact that—

(*a*) The operations take place in three dimensions, as opposed to two in coast defences and over the whole area of the sky, as compared with a limited sector of water.

(*b*) There will be numerous aircraft, both friendly and hostile, engaged and moving at ground speeds up to 200 miles per hour, as against the comparatively slow speed of sea-going craft.

(*c*) The difficulty imposed on the defence in distinguishing between friendly and hostile aircraft, in order to co-operate with the former and interfere with the activities of the latter.

It will be seen from the above points that in anti-aircraft action, by the time the detachment are able to form an opinion as to whether the aircraft is hostile or friendly, immediate action has to be taken.

Aircraft travelling at 200 miles per hour at 10,000 ft. will only be within the effective range of a searchlight for at most 1¼ minutes. This allows no time for the transmission of reports, or for the reception of orders from a superior authority.

The difficulty of locating aeroplanes by searchlights is very largely due to the time taken by the sound to reach the observer, since this interval gives the hostile aircraft an opportunity of altering its course.

It is most desirable to have several beams searching for the suspected aeroplane. It is found that one beam may temporarily illuminate the target in such a manner that the latter can be seen by an observer at another light, although not visible to its own detachment. Under these circumstances it is necessary for the neighbouring detachments to act instantaneously and to direct their searchlights on to the target; any delay caused by awaiting orders from a central control would prevent advantage being taken of such opportunities.

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It was found possible on certain occasions to locate aeroplanes by means of prismatic glasses, and then, having directed the searchlight on to the machine, to expose the beam without previous searching, but this is only possible if immediate action is taken by the detachment, who should not have their attention diverted by telephone instructions.

Normally the group commander would be situated at a distance of some miles from the most advanced light; he would, therefore, be quite unable to appreciate the situation at the point of action, and, should he give orders to search in the direction from which he thought the aeroplane was approaching, considerable errors would undoubtedly arise.

In addition, unless the detachments are trained to independent action, any breakdown in the telephone communications would result in confusion; and it has been found that telephone communications are frequently interrupted during air attacks.

Central control entails in fixed defences considerable expenditure on telephone communications, and in addition a large maintenance and operations staff is required. Although this system may be of great value for intelligence purposes, it would not be advantageous to the personnel operating the light.

In mobile warfare it is difficult to see how any form of central control would be practicable.

The keynote of anti-aircraft searchlight defence lies in the independent action of the lights consequent on a general policy laid down by the group commander.

"EXPERTO CREDE."

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MEMOIR.

COLONEL E. M. LLOYD.

BY the death of Colonel Ernest Marsh Lloyd on the 11th January, 1922, at the ripe age of 81, the Corps has lost one of its best-read and most able writers on military and other subjects. Inheriting from his father a taste for literature, he began early to read extensively, and while yet at school had digested Napier's *History of the Peninsular War*, on which subject he even wrote to Sir W. Napier and received a reply quoting a work of Lucien Bonaparte. His thoughts now turned towards the army as a career, and in June, 1859, he obtained his commission in the R.E. His first station was Dover, where he met his wife, and was married in 1862. In 1863 he contributed a paper to the *R.E. Corps Papers* on "View Sketches of Ground Adjacent to a Fortress." In the following year he sailed for Hobart, Tasmania, where he was chiefly employed on fortification work, and sent home a proposal for a disappearing gun-carriage before the Moncrieff counterpoise system was known. At this time he read widely in mental and moral philosophy, and wrote a pamphlet entitled "The Freedom of the Will Stated Afresh," becoming greatly influenced by the works of J. S. Mill and Herbert Spencer.

In 1872 Capt. Lloyd was appointed an Instructor in Fortification at the R.M. Academy, and became Professor in 1877. During this period he attended the fortress manœuvres at Coblentz. He also edited the new *Text Book of Fortification and Military Engineering* for the R.M.A., the first comprehensive book on the subject which had been used there. Much of this work came from his own pen, notably the very able chapters on "The Attack and Defence of Fortresses" and on the "Historical Development of Permanent Fortification."

In 1882 Major Lloyd was ordered to Hong Kong, where he was employed on Admiralty and Defence works, and for some months undertook the duties of Assist. Military Secretary, in which capacity he was most favourably reported on by the G.O.C. In 1886, when on the Tyne Defences, he published a book under the title, *Vauban, Montalembert, Carnot—Engineer Studies*. In 1887 Lieut.-Colonel Lloyd was appointed Assist. Director of Works (Fortification) at the War Office, and retired in 1892. He also undertook examinations

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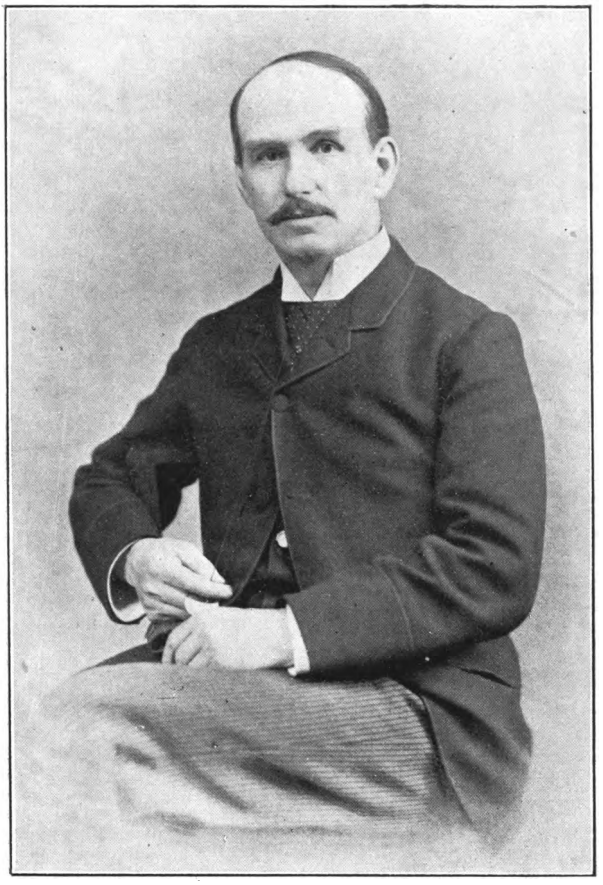

Colonel E. M. Lloyd, R.E.

From a photograph by Maull and Fox.

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in Fortification for the D.G. of Military Education. Lieut.-Colonel Lloyd's active mind, however, sought other work. After election to the Athenæum Club in 1893 he became a contributor to the *Dictionary of National Biography*, for which, during the succeeding five years, he wrote 123 articles, including that upon Wellington. In 1893–5 also appeared essays in the *English Historical Review* on "Catinat," "Marlborough and the Brest Expedition," "The Herse of Archers at Crecy." To the *Journal of the Royal United Service Institution* he contributed "The Campaigns of Saxe" and "The Battle of Albuera"; for the *United Service Magazine* he wrote "Mr. Spencer and Militarism" and "Letters of a Staff Officer in 1794." From '97 to '99 he contributed 35 reviews, mostly of military books, to *The Speaker*. In 1900, after writing short articles on the French and Austrian Armies for the *Encyclopædia Britannica* (*Supplement*), he was invited to join the Military Intelligence Staff as an extra D.A.A.G. In 1900 also he contributed "The Last French Charge at Waterloo" to the *United Service Magazine*.

In 1902 he was given the rank of Colonel in recognition of his "meritorious" services, and was invited to become a member of the Royal Historical Society, on the Council of which he sat in the following year and read a paper on "Canning and Spanish America." Two years later he wrote an article on "The History of the British Army" for the *Quarterly Review*, and began work for the *Cambridge Modern History*. To this he contributed chapters on "The Third Coalition (Napoleon) and, in conjunction with Dr. Prothero, "The English Civil War."

In 1908 Colonel Lloyd published *A Review of the History of British Infantry*.

After this he turned his attention to municipal and other affairs, and was on the Epsom Board of Guardians, of which he became Vice-Chairman in 1913. He was also Hon. Secretary of the Sutton Division of the National Service League, and was on the Committee of the Sutton Boy Scouts' Association, besides being Treasurer of the Sutton branch of the Anti-Suffrage League.

In 1911 he contributed 12 articles to the *Supplement* of the *Dictionary of National Biography*, and wrote reviews for *The Nation in Arms*. In 1913 he became a member of the "Board of Studies in History" (University of London), and in the following year Vice-President of the Royal Historical Society.

When the Great War broke out Colonel Lloyd became Treasurer of the Sutton Division of the S.S.F.A. and helped to form the Volunteer Training Corps. He also became, in 1915, Chairman of the Surrey Committee of the National Service League. In this year he delivered a lecture on "Waterloo" to the Royal Historical Society on the occasion of the centenary of the battle. He also served on a local Tribunal under the Derby Scheme. His last articles were: a review

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of Arthur's *Life of Lord Kitchener* (*R.E. Journal*, 1920), and a review of Lord Esher's *The Tragedy of Lord Kitchener* (*R.E. Journal*, 1921).

So ended the career of this remarkably able officer. His great literary ability, mental power, and energy are amply shown by the number and variety of his writings. The easy and fluent style, the fine choice of language and logical accuracy of everything which Colonel Lloyd wrote made it all pleasant and profitable reading. The position he occupied in the Royal Historical Society alone showed the high estimation in which his abilities were held. It may safely be said that he made a great mark in the literary world. Personally he was a man of a modest and retiring disposition, of unruffled temper in argument, and a charming companion—in fact, a man worth knowing.

It will interest his brother officers to know that the Royal Historical Society has accepted from his family a gift of all his Napoleon books, which fill a separate bookcase in the library of the Society, and constitute a lasting memorial of his work.

J.W.S.

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CORRESPONDENCE.

THE TECHNICAL TRAINING OF ENGINEER OFFICERS.

(*To the* COMMANDANT, S.M.E., CHATHAM).

SIR,

I have read with much interest the article entitled "The Technical Training of Engineer Officers," in the January, 1922, number of the *Royal Engineers Journal*. This article, it is stated, was communicated by you, and I desire to express my satisfaction with the presentation of the case as you have made it.

I agree with you most thoroughly in everything which is stated in the article, and it may be interesting to you to know that we have adopted exactly the same methods which are advocated, in the education of our officers. Ever since I have been at the head of the Engineer Corps, officers have been sent to some of our principal engineering institutions for the purpose of completing their civil engineering studies. I find that this method works out, as was anticipated, in a most satisfactory manner to all concerned. The young men obtain a point of view which they could not get if they were to receive their training or instruction along these lines from other officers, and the mingling with civilians is most beneficial.

There is only one difference between your method and ours, and that is, that our officers are not detailed to these institutions until they have been two or three years in the service as commissioned officers. They are then allowed to live in town lodgings. The senior officer present is in command of the detachment and is responsible for its discipline and is required to submit reports concerning the other officers. These men being older than those which you contemplate sending to such institutions, we find there is no trouble about their engaging in boyish pranks or indulging in actions unbecoming the dignity of officers and gentlemen.

I am in most hearty accord with the statements in the article concerning the character and extent of the training which an engineer officer should receive. It is my opinion that an engineer officer should be so educated and trained that he can take up any work to which he may be assigned. He may not be able to handle it with the same degree of technical skill as a specialist would give it, but he should possess that training and self-confidence which will enable him to exercise administrative functions in any line of duty to which he may be called.

Again expressing my appreciation of the article,

I remain,

Very truly yours,

LANSING H. BEACH, *Major-General,*
Chief of Engineers.

Washington, February 17th, 1922.

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To the Editor of R.E JOURNAL.

SIR,

It is stated in the "Professional Note" which appeared in your January issue that the former was published partly with a view to drawing criticisms on the new system of training R.E. officers.

While I am unable to offer any adverse criticism on the scheme, the advantages of which have been so plainly set forth in the Professional Note referred to, yet there appear to me to be several resultant questions which merit attention. These have no doubt been well considered by the authorities, but it is possible that the views of a junior officer may comprise some point of view which has not hitherto been perfectly appreciated.

The natural corollary to the existence of an Engineer Officer Corps which has been trained on broad scientific lines, which has been taught to think in an engineering manner, which has, in short, been "educated" rather than "instructed" in engineering, is the existence of a very highly trained and expert body of artificers, capable of interpreting and putting into action the necessarily somewhat general instructions of their leaders. This idea I endeavoured to develop in the article published side by side with the Professional Note under discussion.

The next point I wish to suggest has reference to engineering experience. The finest training is useless unless followed by adequate experience, and it must be admitted that no real engineering experience can be obtained in the course of the work ordinarily performed by the R.E. in peace time.

Constructional engineering is limited by paucity of funds and scant demand for large works. The mechanical work of the Army is now chiefly undertaken by the R.A.O.D., R.A.S.C. and Tank Corps.

The electrical engineering of the Army is largely in the hands of the Royal Corps of Signals, and even where useful electric plants are run, such as the Aldershot Power Station, the work is generally carried out by civilians.

The operation of Coast Defence oil engines and minor pumping plants, etc., petty barrack repairs and an annual Fieldwork Course do not afford sufficient engineering experience. This applies not only to officers, but with much worse and more far-reaching results to the rank and file. You cannot keep a man, originally a skilled engine-fitter, employed for five years wiping down a couple of Hornsby Ackroyds in some out-of-the-way station and expect him to remain a competent and up-to-date mechanic. Here it may be remarked that the establishment of a Mechanist Branch, comprising not only supervisory staff-sergeants but also lower grades who would always be employed at their trades and never on cook-house duty, would in some measure ease the situation in creating a demand for work.

If work, and work of real engineering value, cannot be found within the Army, then the only remedy is to transfer, for periods alternating with periods of military service, our personnel to other Government departments or to civilian firms who do carry out engineering work.

The last point I wish to bring forward refers to the Specialist Officers,

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of whom mention is made in the Professional Note. If the right sort of boys are given adequate training for a long enough period as artificers, the best of these would form excellent candidates for specialist commissions. These young men, having had five years' educational and practical training in a R.E. Trade School, and having undergone the normal University Course in company with Woolwich trained officers, would be thoroughly well equipped as junior Specialist Officers. A similar scheme is in force in the Navy, and is being adopted in the R.A.F.

I am, sir,

Yours faithfully,

H. S. BRIGGS, *Bt.-Major, R.E.*

REVIEWS.

MANUAL OF FIELD WORKS (ALL ARMS), 1921.

THE *Manual of Field Works* (*All Arms*), 1921 (*Provisional*) has now been issued, and takes the place of the *Manual of Field Engineering*, 1914. The change in the name of the Manual emphasizes the fact that field works concern all arms, and not the Sappers alone; the Manual will therefore be used by all arms, who are now expected to construct their own field works, thereby releasing the Sappers for technical work. It is divided into five parts, with six appendices and 175 plates, the increased number of plates making the new Manual more bulky than the old, and, being only a provisional edition, the volume is not well bound.

The new Manual develops, by the light of military experience gained during the European War 1914–18, the whole subject of field engineering; it shows that the power of modern artillery has profoundly modified the design of field fortifications; new weapons, such as gas, smoke, mines, tanks, and aeroplanes have necessitated a corresponding development in defensive organizations.

Part I, which deals with Field Fortification, includes a chapter on "The Siting of Trenches," a subject which was dealt with very generally in the old Manual. The importance of machine-guns both in attack and defence has necessitated the clear definition, in a separate chapter, of general principles for rendering emplacements difficult to locate, without at the same time limiting their field of fire or unduly jeopardizing the protection required for the gun and its personnel.

The chapter on "Trenches, Fire Positions and Trench Accessories" corresponds to the chapter on "Earthworks" in the old Manual, the very change of title indicating the advance in such matters as field defences for and against artillery and defence against tanks and gas.

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In the chapter on "A Defensive System" the organizations of an outpost zone, a battle position, and rear systems are clearly set forth, being based on the experience gained in trench warfare, but equally applicable to defensive warfare of a less rigid nature.

The subject of Camouflage is dealt with in a chapter which has been compiled before the appearance of the *Manual of Camouflage*, and it will eventually, no doubt, require a certain amount of revision. The necessity of skill in reading air photographs is emphasized and special reference is made to the measures which gunners should adopt for camouflaging their battery positions.

The chapter on "The Organization of Working Parties and their Tasks" is an important one, for it clearly defines the responsibilities of the infantry officer and gives him valuable instruction as to how to organize his men.

Part II deals with Bridging. Infantry foot-bridges, an artillery trench-bridge and a crib causeway for tanks form subjects of new plates in a Part which otherwise follows much on the lines of the bridging chapters in the old Manual.

Part III deals with Accommodation. Under "Camping Arrangements" the methods of purifying water includes chlorination, but further reference is made to *M.E.*, Vol. VI, *Water Supply*, which is not yet in print.

Part IV deals with Communications, and there is much that is comparatively new in the construction for military purposes of "communications," *i.e.*, cross-country tracks, roads, and tramways.

Part V deals with Demolitions. The properties and method of employment of ammonal and dynamite have been described in detail, for these explosives have been found superior to gun-cotton for special purposes, such as the use of ammonal for heavy deliberate demolitions and of dynamite for boring and blasting work.

It will be found that the work carried out by the Germans during their retreat in 1918 has provided lessons and principles which are enunciated in the section of the Manual under the title of "Demolition of Railways."

The detection of land mines and traps is important and the section on this subject will be of interest to all.

C.R.J.

THE ENGINEER STAFF OF A FRENCH ARMY, 1914-1918.

THE following details are taken from a most valuable encyclopædia of French Staff work, entitled *La Vie d'une Armée pendant la Grande Guerre*, by Colonel Pellegrin,* which describes the organization and working of a French Army Staff.

As in the British Army, the French War Establishments for 1914 did not provide a commander of the Army Artillery or a Chief Engineer. Directly the front became stabilized after the Battle of the Marne, 1914, a General commanding the Engineers of the Army was appointed, with

* Paris: Flammerion, 8.50 francs.

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a Staff consisting of a *Chef de Bataillon* as Chief of the Staff, two Captains and an Administrative Officer, and a Lieut.-Colonel, Director of Engineer Services, to take charge of work carried out by the Army Engineer troops and special working parties, and of the refilling of the Engineer Park. The General of Engineers was made specially responsible for the supply of engineer material, except stores for hutting, cantonments and camouflage, which were under a special director; for the selection and gradual construction of second positions; for the establishment of roads in case of an advance; and for the destruction of communications in case of a retreat.

Attached to the Engineer Service, under the G.O.C., Army Engineers, were representatives of what we should call the Roads Directorate, Water Directorate, Electrical Directorate, and Camps and Cantonments Directorate, with special units, including even a "Company of Hutters" (*Baraqueurs*), and also Local Forestry Units, Sanitary Squads and Anti-Aircraft Searchlight Sections. Further, the following units, which were attached to Armies as required for the following purposes, came under the G.O.C., Army Engineers: Flame Projectors, Gas (*Compagnies Z*) and Mechanical Dug-outs (*Compagnies Mascart-Dessoliers*).

Thus, the position of the G.O.C., Army Engineers, was definitely one of command, and he controlled all the Engineer operations in an Army, except those connected with railways (but including the destruction, if required, of bridges and tunnels), Signals and Camouflage.

J. E. E.

LE HAUT COMMANDEMENT ALLEMAND EN 1914.

By General Dupont (Librairie Chapelot, 136, Boulevard St.-Germain, Paris. Price 5 *fr.*)

This book, written by the Officer who, at the beginning of the War, was Chief of the French Intelligence, is especially interesting as it gives the opinions of the French General Staff on many disputed points. Marshal Joffre, in a Preface, recommends it to all impartial readers as a means of forming a comparison of the work of the General Staffs in the German and French Armies, which he claims will be entirely to the advantage of the latter. The author shows that in the Spring of 1914 the French Staff gave a correct estimate of the number of German active and reserve divisions. He confirms the opinion of General Lanzerac that, although the French Officers expected that the Germans would violate the neutrality of Belgium, they did not expect them to cross the Meuse and Sambre, as this action would too certainly provoke the intervention of England, and General Dupont admits the error and the surprise which resulted from it. He does not allow that the defence of Liége caused any delay in the German programme. Kluck could not move without his convoys, and these would not be ready before the 14th August, but he actually did advance on the 13th. In the second part we follow the wanderings of the German Third Army, which were almost as reminiscent of d'Erlon as the journey of Eleventh and Guard

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Reserve Corps between Belgium and East Prussia. The third part gives the Battle of the Marne, in which the First, Second and Third German Armies all claimed victories, which, with the notable exception of Bülow's right wing, our author is ready to admit, and laid the blame of the retreat on one another. The retreat of the Second Army was forced upon them, but the question of the opportuneness of Hentsch's decision to retire the First Army must be left to history.

LA CONDUITE DE LA GUERRE JUSQU'A LA BATAILLE DE LA MARNE.

By LIEUT.-COLONEL GROUARD. (Librairie Chapelot, 8 *fr.*)

IN this book we read a great deal about the author's previous writings, especially *La Guerre Eventuelle*, published in 1913, and articles in the *République Française*, in which he foretold that the German right flank in an attack on France would extend beyond the Meuse. Needless to say, there is no recommendation of this book by Marshal Joffre, in fact, our author states that the French General Staff made every possible error, and the Commander-in-Chief was not equal to his task. In the operations of the British Army we read of its *lenteur habituelle*, and *extrême prudence*, and yet the writer gives the impression, in describing the Battle of the Marne, that the German retreat began in the First Army, from the threat to its left flank caused by the British advance, and very little credit is given to the French Fifth Army. The author claims to show how the victory could have been made more overwhelming, but he does not give sufficient credit to the successes which had been gained up to this moment of retreat by the German First and Third Armies. He has no doubt as to necessity of preparing against a new German aggression, and this, he says, will have to be met by the French unaided by the British, who have obtained all they require in the destruction of the German Fleet.

F.E.G.S.

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NOTICES OF MAGAZINES.

MILITÄR WOCHENBLATT.

No. 31. *Recent Events in Eastern Siberia.* The *M.W.B.* is always interested in the Far Eastern situation and gives in this issue an account of the factions which are struggling for supremacy.

After the Japanese left Semenoff in the lurch in the autumn of 1921, they took up the democrat Mierkuloff, who became nominally President of the Vladivostock Whites, but really an advance agent of the great powers, for the exploitation of Siberia. Wirbitzky and two more of Semenoff's lieutenants lent him their support, but this is stated to be of doubtful value. For troops he has the remainder of Kappel's corps, which on the death of the latter amounted to about 8,000, and whose trustworthiness and discipline are not above suspicion. Mierkuloff is, however, just able to hold his frontier posts with them. Semenoff has sent a message to his old troops, who appear to be the best of a bad lot, urging them to adhere to Mierkuloff. These troops have recently obtained the mastery of Kamschatka and Okhotsk and succeeded also in capturing Blagouestchensk. When Kappel's 8,000 came up to hold the latter town, difficulties at once arose, and Gleboff, the commander of Semenoff's men, was arrested by order of Mierkuloff.

Semenoff's men promptly mutinied and demanded the return of Semenoff, who, however, while not out of the game, prefers to watch events from Shanghai. He will, however, probably do nothing to embarrass Mierkuloff, so long as the latter is fighting the Bolsheviks.

The Republic of the Far East has been promised help by Moscow, who asked the Irkutsk government to send all its best communist troops to the East. This it accordingly did, and thereby provided a strong reinforcement to the weak nine brigades which constitute the army of the Republic of the Far East. On their arrival in Chita, the seat of Government of the Republic, the troops of one division promptly mutinied, but the remainder seem to have been moved successfully to the front, and will presumably now attack Mierkuloff.

Complaints by Soldiers.—Regulations have been drawn up to show how complaints should be made. A period of seven days is allowed, after which no complaint may be made, and any man making a complaint is allowed to choose a representative to conduct his case. This latter is approved of by the *M.W.B.*, because it tends to eliminate personal animus. In the old army, complaints were always a difficult subject, though the Regulations were good enough. General von Pape used to

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say, " An officer who makes a complaint is either justified or mad." In either case the consequences were unpleasant.

Socialists and Universal Military Service.—It is pointed out how in France and Belgium universal military service is supported by Socialists, though only a few of their German fellows do so. Among the latter the most important is Kautsky, who writes in his book on Social Democracy : " A free people must know how to fight ; its readiness for war is the safeguard of its existence. From childhood it should be taught that no one has the right to call himself a free man, unless he knows how to shed his blood for freedom." The *M.W.B.* hopes that this idea will again be universally accepted, though even when it is, it will only be one step on the long road of preparedness for war which Germany must some day travel if she is to survive.

No. 32. *The Moral Effect of Position Warfare.*—German military writers all agree that, if only it had been possible to keep the war in France open and mobile, the victory would have been theirs in a very short time. Falkenhayn has declared that trench warfare could not be avoided, though its disadvantages were not overlooked, and the present writer goes on to examine what these disadvantages were. The Manchurian war led to exaggeration of the value of entrenched positions, and the fact that passive resistance, like that offered by the Russians, implies the surrender of all claim to skill in the art of war, was overlooked. Victory must be sought in the destruction of the enemy, not in nibbling at him, and capturing nothing but ground. Tannenberg was, and will remain, a brilliant example of the sort of battle that Schlieffen's teaching visualized, for only great stakes can bring great winnings. Goethe's saying : " Who never risks his life will never have a life worth risking ". being as true for nations and armies as for individuals.

The better trained an army is, the greater the loss it suffers through stagnation. This is especially true when the training has been based, as it was in the German army, on individual initiative. The old spirit of personal sacrifice gets changed round to one of self-preservation. Officers lose the opportunities they should have, of showing their superiority in all soldierly virtues and N.C.O.'s, through living too much with their men, lose some of their power of maintaining discipline. In the war, the influx of comparatively wealthy men into the ranks was a further strain on the N.C.O.'s, who were not always able, when off duty, to maintain their position as they should have done, and would have been able to do in the more difficult game of open war. In addition, there was the continual increase in technical armaments, in which Germany, owing to lack of materials, was at a disadvantage.

When Rome was at her height she fought out her battles with sword and spear ; only when her soldiers began to lose their stomach for fighting did she use engines and machines. Similarly, in Frederick the Great's letters, we find the complaint that, whereas formerly victory was won by the courage of the soldiers, now it was gained by skill in avoiding the hostile artillery. But just as, after this, courage once more came into its own, so will it again, and the good and well-trained army will in the next war strive for a war of movement, while the inferior one will aim at stagnation.

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The Officer-hater.—The pacifist Dr. Steiner is said to be a good example of this species; he is also apparently a communist. In a recent article he recommends that all officers who have acted, or even might act in a reactionary way, should be arrested, and rendered harmless. The means by which this is to be done are curious. Their previous service is to be examined and a sufficient number of their comrades and soldiers collected to give evidence on oath of their atrocities and crimes against the laws of war. The evidence need not, of course, bear any relation to the facts, but must be such as is likely to be believed, or, at any rate, difficult to disprove.

The dossier will then be prepared for dispatch to the Entente, should the future action of the officer show the slightest cause for dissatisfaction!

Discipline in the Austrian Army.—A Memorial Service was recently held in Innsbruck for those fallen in the war, and orders were issued for a party of twenty men of the Defence Force to attend. The regimental delegates said that they had no objection to a memorial service in itself, but that it was not lawful to order men to attend, and in consequence most of the men refused to appear. The case has been referred to the War Minister, but no ruling has been given. As the *M.W.B.* says, the state of Austria can hardly be considered satisfactory so long as such things can happen.

No. 33. *Destruction Carried Out by the Germans in France.*—General Ludendorff replies to statements from the Entente side, that the German General Staff, instigated by German manufacturers, deliberately destroyed French and Belgian factories so as to put possible rivals out of action. He says that though no amount of repetition can make a lie into a truth, yet, unless Germany defends herself more actively than she has done hitherto, the lie will be believed. The Entente considers the destruction, without taking any account of the circumstances. It must first of all be remembered that the Entente willed the war, encouraged thereto by the pacifism of Germany and her unskilful politicians. Next, the barbaric action of England, in carrying on a blockade, forced Germany to the decision that necessity knows no law, a decision which even Prince Max of Baden will not quarrel with. If these circumstances are borne in mind, it becomes clear that the responsibility for the destruction lies chiefly with the Entente.

The destruction was of two kinds— that caused by the direct acts of war and that carried out behind the armies and on the L. of C. It is of the latter that the Allies chiefly complain, when they say that it was instigated by German manufacturers. This fairy tale was often heard during the war and, like everything else that came from the Allies, found wide belief in Germany. Ludendorff declares categorically that it is absolutely untrue. When he went to G.H.Q. he heard the tale and tried to find its foundation, without any success. In his Russian campaigns he built more than he destroyed and in the West the same was often true. On the other hand, German industry had to be placed in a position to fulfil the demands made upon it. It needed help all the more because it had to compete against the whole world. Consequently,

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whenever a factory in the occupied territory could not be worked, the machinery was sent to Germany. It was only occasionally possible to work a factory where it stood, because industry must not be imperilled by the chances of war, and German workmen often refused to leave their own country.

Every German knows how short of raw material the country was, and no one can be surprised that everything possible was taken out of the occupied territory; nevertheless, the enemy was protected more than he deserved, for, while German church bells were melted down, those in Belgium were not touched.

The French have complained about the removal of furniture. Owing to the situation it was necessary to build many hutments, and in these the soldier, after his exertions in the trenches, had to be refreshed, consequently the barracks had to be furnished. Similarly, dug-outs required furniture, particularly those used for offices. It is not astonishing that the nearest furniture was taken for these purposes, particularly when much of it came from unoccupied houses. Much of the plundering of unoccupied houses was done by the civil population, as was noticed during the first advance of the German armies in 1914, and much of the destruction that was then carried out was in consequence of the action of the Belgian civic guard and population, contrary to the laws of war. In 1914, and when the trench war began, both sides destroyed equally; or did the Allies never bombard French and Belgian towns? On the contrary, they did so far more than the Germans, because they had more ammunition, and did far more damage by entrenchments, because they had more men. St. Quentin, Cambrai, and many other towns were never touched by German shells.

The battle line from Nieuport to Switzerland, and the devastation that it shows, made a deep impression on all who saw it, but much of the damage was due to the spade, and to the fact that cultivation was impossible for a wide area on each side of the line; wind and weather did the rest.

The destruction by shelling was chiefly due to the allied attacks of 1915, 1916 and 1917 with their enormous munition resources, which were far greater than anything Germany could dispose of. Only at Verdun, on a restricted front, did Germany do any original damage. The rest of her attacks were over ground already devastated.

The destruction carried out during the withdrawal of March, 1917, can, it is true, be charged to the Germans, but even this was to a great extent over ground already destroyed during the Somme battles. In this case it was necessary to take such measures as would enable a weak force to hold a strong one. For this reason 12 to 15 kilometres had to be cleared in front of the Siegfried position, and if it be said that this was far more than was usual even with regular fortresses, the necessity must be attributed to the greater effective range of all sorts of weapons. The law of nations was in no way infringed. Aeroplanes, and not German lust for destruction, necessitated the cutting down of the fruit trees; every front-line soldier knows the value of trees as shelter against hostile planes.

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Apart from tactical considerations, the strategical situation was such that it was essential to have a piece of front which should be moderately safe from attack on a large scale, where tired divisions could rest. Only by this means was it possible to find the reserves with which to meet the British and French attacks of 1917.

In fact, if it had not been for the withdrawal of 1917 to the Siegfried line, the Germans would not have lasted out the year, and from that fact alone the demolitions which were entailed are fully justified.

When in 1914 the 9th Army retreated from the Vistula to the borders of Silesia, only the railways were destroyed, because the situation demanded nothing more.

In the autumn of 1918 German demolitions were on a larger scale; they only barely corresponded, however, to the situation and in many respects fell far short of requirements. Coal mines are in a category by themselves, as will be admitted, and it was necessary to put them out of action thoroughly and for as long as possible; it could not be foreseen in August, September and October that the revolution of 9th November, 1918, would break the armies, and a much longer resistance was counted on. In any case, the destruction was no more than was carried out in the Roumanian oil-fields by the English "Engineer or Colonel" Thomson. Germans would have themselves done exactly the same to their own Upper-Silesian coal mines, if, in 1914, they had had to leave them to the Russians.

General Ludendorff says he will not continue the subject. As time goes on, the circumstances which compelled action are forgotten, while the results of the action remain. This fact is used by the allies in making their case for the oppression of Germany. But it was iron necessity, and not wilful lust that led to the measures which G.H.Q. had to take to counter the lawless actions of the enemy. War is at all times a rough business, and seems mad and wilful to those who do not know it. For this reason the allied statesmen ought to stop their attacks on the German soldier's honour. They ought to have the courage to speak out openly and say "might is right."

The use of Poisonous Gas in the War.—The writer admits that Germany was the first nation to employ gas in war, when she used it with partial success on the Yser in 1915. The cry raised by her enemies at this so-called barbarous weapon was not justified because, he says, it is well known that the French, for long before the war, had been carrying out experiments with gas, and it was only the skill of German chemists which enabled Germany to get a temporary start in its use.

Whether the French actually fired gas shells before the Germans did, is, he declares, an open question, for many heavy shells cause death without visible wounds. The writer then proceeds to compare the Washington resolution on the subject of the use of gas, with the opinions that have appeared in the press, and concludes that no one, least of all England, is likely to be bound by any pious resolutions if national safety is in question.

No. 34. *The Comparative Strengths of Modern Armies.*—General von Altrock gives a table showing the peace strengths of armies

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as percentages of the total populations. By giving England an army of 341,000, her percentage is 0·72. Some others are :—

Russia	1·23	per cent.
Germany	0·17	,,
France	2·19	,,
Italy	0·57	,,
Poland	1·10	,,
Roumania	1·25	,,
Jugo-Slavia	1·53	,,
Checho-Slovakia	1·47	,,

The remainder are mostly under 1 per cent. The writer points out how hopeless Germany's position is shown by these figures to be, particularly because she cannot form any reserve. The right of self-defence should not, he says, be taken from any nation.

L. CHENEVIX-TRENCH, *Major, R.E.*

April, 1922.

REVUE DU GÉNIE MILITAIRE.

November, 1921.

Roads and Tracks, by Colonel Normand. (Notes issued to the 12th Engineer Regiment). The construction of a new road requires, say, 1·20 cubic metres, per metre run, of material, for a single-way road, and 2·20 cubic metres for a double-way road. A new road should never be undertaken unless time and transport are available. A wagon carries ·75 cubic metres ; a lorry 3·00 cubic metres ; a train, 350 cubic metres. The maximum rate of construction is 100 metres per day for a road five metres wide, per 100 skilled men. This is reduced to 60 metres if the men are unskilled.

2. It is always better to improve an existing road than to build a new one, as, with the latter, settlement continues for a long time.

3. The soling must be hand-packed ; and laid preferably on excavated ground, cut to camber, and not on made ground.

4. The trace is fixed by the places to be connected, and by bridges, railways, streams, etc. Curves must not exceed 10 m. for horse transport or 40 m. for motor transport, and gradients 1 in 20 for flat country or 1 in 10 for hilly country. If possible, roads should pass near quarries.

5. Camber must be slight ; say, 1 in 50.

6. The foundation must be firmly supported on both sides by a solid edging of large stones, sometimes by a pavement, or by carrying the foundation to the edge of the excavation, to trees, etc. Vehicles running over the edge cause much damage. This must be prevented. An earth bank is only allowable to prevent vehicles upsetting into large ditches, as it tends to bring mud on the road. Pickets and large stones at 5m. intervals are very effective. Longitudinal baulks kept in place by pickets are effective, but expensive.

7. The disposal of water is essential for the preservation of roads. Longitudinal ditches should be 1·50 m. clear on either side or, failing

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space, should be revetted with hurdle work. The road should be connected to these ditches by drainage channels every 5 m. at least in cuttings. Storm water drains should be dug above roads. Allowance of 50 cm. width of ditch for every 1,000 *hectares* of surface collecting rain-water.

8. Mud holds moisture, destroys the binding, and causes dust. It should be got rid of, or prevented, by sweeping in wet weather or by shovelling. Watering places by a roadside should be forbidden. Corduroy roads leading to camps and watering places, if kept clear of mud for 50 m., prevent mud being brought on to the road. Mud removed from a road should be taken well away, so that it does not get back to the road again.

9. When roads have to be widened this should be done equally on both sides, but one side should be completed throughout before the other is begun.

10. *Upkeep of Roads*: (*a*) Above all else, drain; (*b*) keep free of mud; (*c*) never fill up holes with earth, but use stone, and ram or roll; (*d*) if a repair has to be made, loosen the old metal if possible by machinery, and roll the new metal with the old, binding it into the old surface; (*e*) do not interrupt traffic, do one side of the road at a time; (*f*) replace wastage caused by use and the removal of mud and dust, and cover with marl or chalk if very dry.

A small maintenance party is essential. During a thaw the pace of light motor traffic should be reduced to 35 km. an hour, and no heavy axle-loads should be allowed until the road is dry.

11. *The Re-establishment of Battle Roads.*—First ensure the passage of field-guns and then try to restore the road on its old site. In trench warfare roads are apt to be buried 30 cm. or more in mud. Where the road crosses trenches repair by filling and not by bridging. Where craters occur make deviations of corduroy road. Temporary bridges should be sited clear of the sites of the permanent bridges. Work should be done only on the roads selected by commanders. As much use as possible should be made of materials from ruined villages, etc., metalling being reserved for the surface. Seek out mines and booby-traps, and, lastly, leave a maintenance party.

12. *Traffic Regulations.*—Place numerous sign-posts, with transparency lamps for night, and make motor traffic move slowly. The different pace of horse and motor traffic can be arranged for by having different roads, cross connections between roads, or fixed hours for horse and motor traffic respectively. Intervals of 50 m. should be maintained between groups of vehicles to facilitate the movement of faster traffic.

13. *Organization of the Road Service in the Army.*—Soon after the outbreak of war, in each Army a Road Service was organized under the general commanding the engineers, commanded by an engineer of the *Ponts et Chaussées*, and composed of companies of workmen, officers and administrative officers who commanded sectors, companies of reservists of the territorial engineers, civilians, men undergoing punishment, occasionally of foreigners and colonials, and prisoners. In 1916 the Fourth Army were employing from 2,400 to 4,000 men. The Verdun Army had 92 companies. In addition, for transport, etc., sections were

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organized each of 25 carts or 18 motor vehicles ; steam, petrol and horse-rollers, watering carts, sweepers and stone-crushers.

14. *Tracks.*—These should avoid all important works. Usually sign-posts only are required, vehicles then make the track. Sufficient width must be allowed for the track to be moved when it becomes bad. Fill up holes with anything but earth (this does not apply to footpaths). Only use sweepers in very bad places. Insure the run-off of water, put in culverts of fascines, pickets, etc., where required. Only build bridges when deviations cannot be made more quickly. In sand, fascines can be used at right-angles to the line, or, more economically, longitudinal ones kept in place by pickets ; the ends should be firmly bedded.

Tracks are very useful for caterpillars.

C. LA T. T. JONES, *Capt.*

REVUE MILITAIRE GENÉRALE.

December, 1921.

The Revision of the Regulations. Continuation of the article by "Lucius," dealing with the end of the fourth period. The Instructions issued at the end of 1916 were a first effort towards reconciling order and method with rapidity in execution, with a view to reaping the full advantages of success. A Provisional Note of 27. 9. 16 on the subject of attack by small units fixed the new organization of the infantry battalion at three companies and a M.G. company, and determined the establishment of specialists. It announced that infantry could now hold their ground more firmly in defence, and in attack had recovered the power and ability to manœuvre which had been diminished by trench warfare. The way having been opened by the artillery, it should now be possible for infantry to exploit a success with its own resources, and each body should have a plan prepared for doing so ; the first success must be completed by the capture of those supporting points the conquest of which might have to be dearly bought next day, and points abandoned by the enemy should be occupied at once. However, as a check to rashness the battalion commander was warned that the following up of a success is achieved, not by infantry alone, but in combination with the artillery. The note also reduced the density and increased the depth of infantry formations, the interval between rifles is raised to four or five paces, which appears to be a maximum if continuity in the line is to be preserved. The Instruction of 8. 12. 16 on the employment of cavalry sums up previous instructions in one document, and points clearly towards the infantry model and action on foot. The missions to be fulfilled will be the immediate exploitation of a success in combination with the other arms, or distant exploitation in the execution of which the larger cavalry formations will have to depend on their own resources. The cavalry of the division or corps is the true co-partner of the infantry, and ought to come into action directly the latter finds it has no continuous obstacle in front of it. The larger formations must have a "pursuit plan" and put it into operation, directly the enemy's

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defence is breached or he retires on a wide front. An Instruction of 12. 12. 16 deals with inter-communication and regulates the employment of aircraft in the battle.

The Instruction of 16. 12. 16 deals with the combined offensive and marks a distinct advance. It commences by pointing out that recent tendencies, to reduce the width of front attacked, to select objectives which are too close, and to increase the interval of time between two successive operations, cannot assure the best results, but limit the success and give opportunities to the enemy to recover. Limited objectives lead to a narrow conception of the battle, and an easily achieved success is then liable to come as a surprise and to find no definite plan ready for exploiting it. On the contrary, attacks must be conceived of as wide in extent, involving the capture of the enemy artillery, and must be executed as rapidly as possible one after the other. Method is above all applicable to the period of preparation, and is extended to the period of execution only as far as plans of action can be arranged beforehand; rapidity and continuity of purpose are then paramount. The greatest attention should be paid to places where the advance is expected to be easy; the artillery preparation will be carried out not only on the first position, but on any others within range, and infantry will advance with no delay beyond that necessary for restoring order or the destruction of fresh obstacles. In consequence the objectives assigned to an attack will be a minimum which is bound to be reached, but beyond which progress can and ought to be made, thus realizing the *tactical exploitation* of the success. Once the organized positions have been carried, commences the *strategical exploitation* carried out by the larger formations held in reserve for that purpose. It is nothing less than the pursuit, but a pursuit in which the infantry will be husbanded by the support of artillery. The time taken in changing position of the guns will be reduced by detailed change of position plans prepared to ensure that there are batteries always ready to fulfil their different rôles, whatever the infantry progress may be. Attacks will be by successive stages, each limited only by the resistance met with. Arrangements for the attack will be directed more and more to the preparation of numerous plans to ensure rapidity of execution, and as far as possible eliminate the chance of being surprised by success. In the execution, a large measure of initiative must be left to the officers on the spot, to ensure energy and boldness. It is, however, pointed out that good order, rapidity, continuity and constant artillery support for infantry are necessary conditions, and that for infantry good order is more important than rapidity. Artillery is constantly enjoined to destroy the enemy's guns (neutralization is only allowable in default of anything better) and obstacles (but now confined to essential elements of the defence) to the march of the infantry. The commencement of the infantry attack depends entirely on the progress made by the artillery preparation. Tactical surprise is always to be attempted by simplification of the earthworks undertaken, by the general use of camouflage, by strict control of conversations and correspondence to ensure secrecy, and by less complete destruction by the artillery; but even now the preparation must extend to five or six days, although

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neutralization of the enemy's artillery would allow of its being considerably shortened.

At the end of 1916 the resources of the offensive may be considered adequate to the requirements of position warfare, and, although there was a deficiency of heavy Q.F. guns, a judicious employment of those existing permitted of the rupture of the enemy's fortified front being confidentially anticipated. At this time the enemy was much exhausted, and for the first time had made overtures for peace, while the numbers of the Allies nearly attained their maximum. The year 1917 appeared to dawn happily for the Allies, but new defensive tactics and alteration in the French High Command played them an ill turn.

(*6th.*) *The Combined Offensive in Artois and on the Aisne* (*9th April to 15th May*, 1917): (*a*) *The Preliminaries.*—General Nivelle now replaced General Joffre and for political, economic and moral reasons it was desirable that the war should be ended as quickly as possible. Joffre's plan had been two attacks, the principal one between Oise and Arras, commencing on 1st February, the other, less important, between Soissons and Rheims about 20th February. This plan was remodelled by Nivelle, who wished the principal effort to be made on the Aisne, although the attack on the Somme was still to be first in order, and destined more to attract the enemy's reserves than to effect a breach; the changes entailed postponed the attack till April. It will be seen that the plans were based on a system of multiple attacks intended progressively to absorb the adversary's reserves; not on a system of successive attacks on a single wide front. Each attack was to be on such a wide front, however, that dangerously narrow salients would be avoided and manœuvre would be possible, and it was hoped that the later attacks would effect a breach owing to the enemy's reserves having been drawn away by the earlier attacks. Success would be more probable if the separate attacks followed each other closely in point of time, but this supposes sufficient material and personnel to be able to maintain the later attacks without starving the earlier ones. General Nivelle's plan was about to be executed when the enemy forestalled events by retiring on the Hindenburg line with the object of gaining the time he required for the development of his submarine campaign, and to collect reserves of men and munitions. The retreat reduced the length of his line by 40 km., got rid of the vulnerable salient at Noyon, and placed the Allies on a devastated zone unsuited to the offensive.

(*b*) *The General-in-Chief's Plan, Based on Rapidity.*—General Nivelle was impressed by the necessity for an early termination of the war, and was a wholehearted advocate of the Instruction of 16. 12. 16. Unfortunately he emphasized the principles of rapidity and boldness to the neglect of good order and method, and aimed at a dashing attack, breaking through the enemy position in 24 to 48 hours, forgetting that the defence was now so deep that the attacking guns must change position to bombard the whole of it, and that successive preparations were necessary and took time. In fact, the General's plan was a return to the already discredited Instruction of 16. 4. 15, but meanwhile, fortification had developed and the Allies had not sufficient heavy Q.F.

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guns to prepare for attack in one operation the whole of a deep position of defence.

(*c*) *Resumption of the Offensive in April*, 1917.—The Allied offensive began on 9th April according to plan, but except on the British front produced meagre results.

(*d*) *The Results.*—The anticipated breach was not effected, and from 21st April all idea of breaking through was abandoned, and attacks on limited objectives were reverted to, with a view to wearing down the enemy, until operations were suspended on 15th May. Shortly afterwards General Nivelle was replaced by General Pétain.

(*7th.*) *Conclusion.*—It is unfortunate that the Instruction of 16. 12. 16 should hardly have seen the light before it was modified, the order and method it inculcated neglected, and its boldness exaggerated. All the operations show that surprise is still an important factor of success. In the earlier days of the offensive, especially if surprise can be obtained, it is certain that the assailant suffers fewer casualties than the defenders, but once equilibrium is established the losses on each side tend to become equal, and that side will then be favoured which can obtain for itself the ability to manœuvre. Mastery of the air is now a powerful factor of success.

(*To be continued.*)

A. R. REYNOLDS, *Colonel.*

REVUE MILITAIRE SUISSE.

No. 12.—*December*, 1921.

The Reichswehr—Major de Vallière's article on this subject, begun in the number of the *Revue* for July, 1921, is continued. The successive stages through which the Imperial German Army was, after the Armistice of 1918, transformed into the Reichswehr is dealt with. Major de Vallière points out that the Great General Staff was, in 1917, still confident that the Central Powers would emerge victorious from the trial of strength on the hard-fought fields of the Western Front, and arrangements were consequently made gradually to begin the liberation of men with the colours, so that the economic reconstruction of Germany might be taken in hand the moment the "Cease fire" sounded on the battle-fields. The defeat of German plans in 1917 caused the original demobilization scheme to be cancelled. The critical situation through which Germany passed during the final stages of the Great War is dwelt upon in the original article, and it is made clear that it was largely due to the firm hand with which Noske, the Socialist War Minister, restored discipline in the ranks of Germany's new levies that his country escaped the unhappy fate of Mighty Russia. The return to the Fatherland of the Field Army at the end of 1918 also seems to have had a sobering effect upon the German people. Officially, the old German Army was demobilized in November, 1918, but there were still 300,000 unmobilized soldiers in April, 1919; it was not till October, 1920, that the late Kaiser's Army can be said to have been finally dispersed. In the meantime, General Mærker, Commanding the 214th Infantry Brigade,

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raised a Volunteer Corps, the members of which were liberally treated in the matter of pay and rations by Noske. This Corps, the forerunner of the Reichswehr, maintained order in the interior, and came in useful when the communist gathering, numbering some 150,000, in Westphalia had to be taken in hand and dispersed by force. The Reichswehr was brought into existence in March, 1919, by a law passed at Weimar by the National Assembly: its strength increased from 300,000 men (28 brigades) on May 1st, to 450,000 men (43 brigades) on October, 1919; however, by the end of 1919 the strength of the force had been reduced to about 100,000 men, organized in 20 " mixed " brigades. This brigade organization was in violation of the provisions of the Versailles Treaty: each " mixed " brigade really constituted the nucleus of an Army Corps. Warned by the measures adopted by Prussia to evade the conditions imposed by Napoleon after Jena, France has kept strict watch on her eastern neighbour: she does not desire to have a surprise sprung on her. The possibility of secret measures being adopted in the Fatherland with a view to enabling Germany to escape from the consequences of the defeat experienced by the late Kaiser's hosts on the fields of Flanders and Northern France during the recent struggle cannot be put on one side as something too remote to be guarded against.

Rapidity of Attack in the Great War and After.—M. Fleurier's article on this subject, begun in the number of the *Revue* for November, 1921, is continued; the campaigns which have been in progress since the Armistice of November, 1918, was signed, are discussed. It is pointed out in the original article that the causes which led to the stabilization of fronts in the Western theatre during the Great War have been absent in the theatres in which operations have continued since November, 1918. M. Fleurier examines the causes which were chiefly responsible for the stabilization of the fronts in France and Flanders, and compares the conditions prevailing there with those under which the subsequent campaigns have been conducted in other theatres. He sums up his conclusions under two main heads (*a*) observations on strategy, and (*b*) observations on tactics. He points out that the war of movement has returned, and that the *strategic manœuvre* has once more a place in plans of campaign, whilst in the case of the tactical field, a great variety of conditions have had to be faced, indeed, from police action against insurgents to pitched battles. The article affords interesting reading.—(*To be continued.*)

NOTES AND NEWS.—*Switzerland.*—In normal circumstances, the annual contingents for the Swiss Army amount, under the Military Service Law, to 30,000 men. In 1917, 27,350 recruits were actually called up; in 1921, owing to the sum voted in the Budget not being sufficient to call up the whole of the class reaching military age in that year, the annual levy was reduced to 22,900 men; this number has been further cut down by 2,800 men in the current year's levy. The young Swiss is exceedingly keen to put in his military service, and considers it a stigma to be rejected for the Army. To meet the exigencies of the moment, the medical examination of recruits has been stiffened, and men quite fit for service are being rejected; much dissatisfaction has

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been caused by a resort to this expedient to cut down the numbers called up.

France.—An appreciative note is contributed by a special correspondent on General Humbert, Governor of Strasburg, who died on November 9th, 1921, at the age of 59. At the beginning of the Great War he was commanding a Brigade, and rapidly rose to the command of an Army (July, 1915).

Portugal.—A special correspondent calls attention to the main features of the proposed new Army organisation: they consist in (1) the creation of two new Directorates in the Ministry of War, *viz.*, (*a*) Directorate of the General Staff, and (*b*) Directorate of Army Services; (2) the creation of an Air Force; and (3) the creation of five military territorial districts in place of the eight military divisions. Among the other proposals which have been made is one for the fusion of the Field and the Garrison Artillery into a single regiment. Considerable controversy has arisen on the question, and apparently the leading experts in Portugal are opposed to this part of the New Army Organization Scheme.

No. 1.—*January*, 1922.

Rapidity of Attack in the Great War and After.—M. Fleurier's article on this subject, begun in the number of the *Revue* for November, 1921, is continued. The part of the article under notice contains further observations on tactics. The important question of the employment of cavalry is dealt with; it is pointed out that since the termination of the fighting on the Western Front many opportunities have been afforded to cavalry for playing its old rôle in war; the experience thus gained has necessitated a revision of the death sentence passed on the mounted arm. Aviation, tanks and field fortification each receive mention in the original article, and technical observations sum up the author's conclusions on such subjects as the rifle, automatic guns, grenades, trench mortars, artillery and ammunition. Finally, M. Fleurier points out that, as was the case in former ages, so in the last war, technical improvements in the armament and equipment of troops appeared at first to tell most in favour of those resorting to the defensive, but, as the campaign continued, it was those on the offensive who derived the greatest gain from the advances made in the technical field. The extended use of automatic weapons, for instance, provided the attacking infantry with support and protection up to the latest stages of an advance, owing to the continuity of the fire-action. M. Fleurier recognizes, and emphasizes, the fact that the offensive manœuvre can alone succeed, however, where adequate measures are adopted for promptly providing all that is necessary for rendering an attack swift and for maintaining the rapidity of the advance.

Search for a New Discipline.—Captain Cingria's article on this subject, begun in the number of the *Revue* for November, 1921, is continued. Reference is made to a new system of discipline (the Montesori system) introduced in certain Government schools in the Canton of Ticino; a system which appears to have proved eminently successful with school

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children. Captain Cingria recognizes that reforms which have proved successful in school discipline will not necessarily meet the requirements of military discipline; he, however, inclines to the view that something in the nature of the Montesori system might be introduced into some phases of military life, but makes no definite recommendations—a search for the solution which will satisfy his ideals being still continued. In a pamphlet entitled "L'organisation et l'instruction de l'armée," published in Switzerland in 1920, General Léo Keresselidgé, its author, holds up the organization of the Swiss Army as a model worthy of universal imitation. Captain Cingria takes exception and expresses the opinion that in the matter of discipline the Swiss militia lags behind the monarchial armies of the present day.—(*To be continued.*)

NOTES AND NEWS.—*Switzerland.*—Attention is called to the controversy which has been taking place on the subject of the "neutralization" of Savoy: General Wille and Colonel Sprecher, of the Swiss Army, have contributed their views on the subject in recent numbers of the *Allgemeine Schweizerische Militärzeitung* in reply to views which have been expressed in the *Revue* on the subject of the League of Nations. Colonel Sprecher is strongly of opinion that Switzerland should continue to maintain an adequate Army, and, having regard to the unsettled state of Europe, the preparation of schemes of defence to meet all possible contingencies likely to arise should be taken in hand.

France.—A special correspondent calls attention to the functions of the *Conseil supérieur de la défense nationale* and the *Commission d'études*; the provinces of the two bodies are now regulated by a Decree of November 17th, 1921, and certain Decrees of earlier date. He pleads that the scope of the responsibilities of the *Conseil supérieur* should include that of co-ordinating the activities of all Government Departments, so far as they affect matters of military interest, in order that the part these Departments may be called upon to play in a time of war may be duly considered and planned out in advance with foresight. He further urges that the *Conseil supérieur* should not have its time taken up exclusively in dealing merely with matters affecting rifles, catapults, etc., as has been customary in the past, but should now survey a much wider horizon: instead of considering the matter of mobilization as being the sole domain with which preparation for war is concerned, the *Conseil supérieur* should extend its oversight to all questions which are connected with the provisions and arrangements which have to be made for the conduct of a modern war. Some pertinent remarks are made concerning the respective rôles which the *Conseil supérieur* and the *Commission d'études* should each be called upon to play in the State organization.

W. A. J. O'MEARA.

ERRATA.

In *R.E.J.*, April, 1922, page 190, line 4, for *Seres* read *Sedes*.
Page 202, line 31, for *Psers* read *Piles*. Line 39, for 8 *in.* read 8 *feet*.

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AERIAL ROPEWAYS.

By CAPT. and BT. MAJOR F. H. BUDDEN, M.C., R.E.

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I.

AN aerial ropeway is a means by which loads can be transported from one place to another in carriers suspended from cables, which are supported on standards spaced at various intervals. By this means it is not necessary to prepare an expensive roadway such as is required for motors, railways, etc., nor is it necessary to follow the contour of the ground, but gaps can be crossed, mountains climbed, without very great expense.

II. TYPES.

1. Aerial ropeways may be divided into two distinct types: (*a*) Monocable, where a single endless rope is used to support and move the loads; (*b*) Bicable (or Tricable, as it is called on the continent in Europe), where the loads are supported on two carrying ropes and moved by one endless hauling rope.

2. There are also certain variations of these types, such as the "Fixed Clip System" on the Monocable type, and the "Jig-back" or "To-and-fro System," which is applicable to both types. As a general rule, both the Monocable and Bicable types are so arranged that it is not necessary to stop the hauling rope to attach or detach loads at the stations at either end of any one section.

III. CHOICE OF SYSTEM.

1. There is a certain amount of difference of opinion as to which system, the monocable or the bicable, is the better. On the continent the bicable (or the tricable) system is preferred, while in England the monocable is generally installed. The reasons for this difference of opinion are that, when aerial ropeways were first introduced, the bicable system was adopted by continental makers and was developed to such an extent by two German firms that for many years the bicable system was in practice the better of the two for all heavy work and steep gradients. Since then the monocable system has been improved by English firms, especially by Messrs. Ropeway, Ltd., so that it is now a serious competitor to the bicable system, and in many cases has ousted the latter system.

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2. *The advantages claimed for the bicable system are that :—*

(*a*) the carrying and hauling ropes have different functions to perform and can be designed to fulfil them, *i.e.*, the carrying ropes can be made large and stiff enough to carry heavy loads, while the hauling rope can be made flexible. Also in the case where the loads in one direction are heavier than the loads in the opposite direction, the carrying rope for the lighter loads can be made smaller. This is not possible in the case of the monocable system ;

(*b*) the life of the ropes is longer ;

(*c*) gradients as steep as 1 in 1 between tops of trestles can be traversed ;

(*d*) heavier loads can be carried ;

(*e*) trestles can be spaced at a greater distance apart.

3. *The advantages claimed for the monocable system are that :—*

(*a*) it is cheaper in first cost ;

(*b*) easier to transport and erect ;

(*c*) easier and cheaper to maintain ;

(*d*) there is less likelihood of damage to the system in high winds, as with the bicable system the hauling and carrying ropes are liable to get caught up together ;

(*e*) it is safer, as the single rope is always passing under observation at the terminal stations and can be watched for the first sign of wear, and moreover can be more easily lubricated. Also, when the rope on the monocable system breaks the loads merely sink to the ground, whereas in the bicable system when the carrying rope breaks the hauling rope still goes on and the loads are liable to damage the trestles, and should the hauling rope break, the loads still remain on the carrying rope and are liable to crash into each other ;

(*f*) for all practical purposes the monocable can traverse all hills that are likely to be met with, as, with the improved carriers introduced by Ropeways, Ltd., gradients of 1 in 1½ can be climbed ;

(*g*) loads can now be arranged to be dumped automatically where required, although at first this was only possible with the bicable system.

4. From the above it will be seen that each system has certain advantages, and it depends on the ground to be covered, the loads to be carried, and the total tonnage to be transported per hour whether the monocable or the bicable, or a combination of both, should be installed, and only an expert can decide this.

5. For instance, in case of a long line in which occurs a very large span, and which with a monocable might entail the use of a very

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heavy rope throughout the section, it might be advisable to instal a bicable line and use heavy carrying ropes over the long span only, the remainder of the section having carrying ropes of smaller diameter.

6. In all cases the advice of an expert should be obtained, and any extra expense entailed will be repaid many times over by a decrease in the running costs.

IV. Location and Design of Ropeways.

1. After it has been decided that it is desirable to join up two places by an aerial ropeway, various details in connection with the exact location and design of the ropeway have to be settled.

2. *Location of stations.*—In this connection attention must be paid to the following points:—(*a*) loading and unloading stations should be at convenient points for transhipment; (*b*) the straightest route is preferred, provided that it does not entail too great spans. Details of limiting spans are given later; (*c*) length and grades of each section should be adjusted so that suitable positions can be found for intermediate stations and the power of the motors selected for use can be fully utilized. Where the gradients are favourable, sections have been made as long as five miles on the monocable system, such as for the Pure Salt Co., Spain, but the normal section is, of course, less.

3. *Positions of Motors and Tensioning Arrangements.*—A line of considerable length consists of a number of sections, each of which is worked by its own motor or motors, and for each of which there are separate tensioning arrangements. For convenience of supervision and cheaper cost of running it is generally preferable to have the motors of two adjacent sections together so that in a line of two sections, the tensioning arrangements might be at the loading and unloading stations, while the motors working both sections might be situated at the intermediate station for convenience of supervision.

4. But there is another factor which must be taken into account, and that is that it is preferable to have the motor, if possible, at the higher station, in order to have direct haulage on the rope. This is said by Italian experts to reduce the power necessary by 20 per cent., and also the wear of the rope.

5. *Gradients.*—In the case of the bicable system gradients of 45°, or 1 in 1, can be surmounted, whereas with the monocable system the limiting gradient is 1 in 1½, and this is only possible with a much-improved clip introduced by Ropeways, Ltd., and described under "carriers." Previous to this the limiting gradient was 1 in 2½, and this was said to be one of the disadvantages of the monocable system.

6. Italian experts state that for heavy lines the change of grade at any trestle should not ordinarily exceed 3°, and the maximum

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allowable is 4°. For light lines, however, the change of grade may be as high as 8°.

7. *Curves.*—Curves are not desirable on either system, but are less harmful on the monocable system. In any case the change of direction at any one standard should not exceed 1°. An example of what has been done in the way of curves can be found at the Shropshire Mines Ropeway, Minsterley, England, built on the monocable system.

8. This line is 25½ miles long and is designed to carry 20 tons per hour. A curve occurs about 13,910 ft. from the loading station and is 2,703 ft. long. The angle between tangents is 6° 43′, and the curve is completed in eight spans with a deviation of about 1° at each trestle. On the trestles in the curve the sheaves are mounted as usual on balance beams. The balance beam carrying the sheaves is suspended on a laterally-swinging arm which permits the beam and sheaves to swing outwards or inwards from the standard while the load passes, and this obviates any tendency for the rope to mount the flanges of the sheaves owing to change of direction. The wear on the sheaves is admitted to be slightly increased owing to the curve, but it is not great (*vide Sketch* 1).

9. *Spacing of Standards.*—It is difficult to lay down any definite ruling on this point. The spacing may vary in the case of a bicable system from 1,500 metres, when crossing a gap, to 25 metres, when changing slope at the crossing of a spur.

10. In the case of a monocable system one of the largest gaps crossed was 1,090 metres between standards on a ropeway for the Porco Tin Mines, Ltd., Bolivia, S. America. The longest recorded span, however is one of 3,600 ft. in the Andes. An average spacing on ordinary ground would be anything between 100 and 200 yds. between trestles.

11. *Capacity of Line and Individual Loads.*—When possible, individual loads should be kept to about 1 per cent. of the hourly capacity for capacities above 10 tons per hour. Heavy individual loads tend to increase prime costs.

12. Most ropeways are designed for a capacity from 20 to 50 tons an hour, but even with the monocable system a capacity of 150 tons an hour has been obtained (for the Compañia Española de Minas del Ref, Spain).

13. If, however, special loads, such as timber in log, have to be carried, the problem becomes different. In this case the design has to be worked out for the maximum load anticipated.

14. Generally the prime cost of the installation is largely dependent on the maximum individual load to be handled.

15. The following table, giving a rough idea of the capabilities of the various systems mentioned, shows the maximum lengths,

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capacities and loads carried on various lines at present working or in course of construction :—

System.	Present maximum lengths.	Present maximum hourly capacity.	Present maximum individual load.
Monocable ...	80,196 yds.	200 tons	1½ tons
Bicable	38,800 ,,	250 ,,	2 ,,
Fixed Clip ...	2,330 ,,	8 ,,	4 cwts.
To-and-Fro ...	1,850 ,,	Passenger's weight unknown.	17 tons

16. *Speed of Hauling Rope.*—The usual speed is about 2 metres per second, or about 400 ft. per minute, although in some cases a speed of 2½ metres per second has been allowed. In case of urgent necessity a speed of 3 metres per second can be allowed for a short time, but it has been found that carriers can best be fed on to the rope at a speed of about 400 ft. per minute, and as it is very desirable that the carrier should be travelling at the same rate as the hauling rope when the clip engages, this is the usual speed, otherwise the hauling rope is liable to be worn out too quickly.

17. In many cases automatic regulators are used to regulate the speed of the motors under a light load.

18. *Dip.*—Italian experts allow in practice a dip of 4 metres vertical in 100 metres of span. It often happens that the dip is the determining factor in calculating the diameter of the carrying rope. In calculating the catenary, the ropes are selected to carry a load greater by 50 per cent. than is expected for the actual total load.

19. The dip can also be obtained from the formula

$$\text{Dip} = \frac{L^2 W}{8 T}$$

where L = span, W = weight per unit length, 8 = constant, T = tension, and from this the supporting trestles can be placed.

20. It sometimes happens, however, in practice, that when the rope is fully tensioned it floats or rises up from the supporting trestle, due to some slight error in calculation. To overcome this, some Italian makers provide clips to hold the carrying rope down on the supporting saddles. This is only done for light lines which are erected in a hurry, as often happens in war.

21. Otherwise a so-called factor of safety is employed by continental makers, that is, the denominator 8 T in the formula $\text{Dip} = \frac{L^2 W}{8 T}$ is multiplied by some constant which varies according to the ropes employed. In the case of locked coil ropes, the factor may be 1·1, and in the case of spiral ropes up to 1·5. By a use of some such factor the calculated dip is less than the actual, and so the supporting trestles are made slightly higher than it is theoretically necessary, but any possibility of floating is obviated.

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22. *Diameter of Carrying Ropes.*—It has been proved by experience that most trouble is caused by breaking due to bending near the saddles, and for this reason, in order to obtain the diameter of the carrying rope required, some firms employ formulæ based on stresses due to bending.

23. A formula often used is :—

Weight per metre of rope $= \frac{0{\cdot}85}{100}$ [(weight of carrier) + (distance between carriers in metres) × (weight of hauling rope per metre)].

This is for spirally-wound ropes.

With locked coil ropes the factor 0·85 becomes 1·05.

This formula works well for small lines up to about 50 tons capacity hourly. For each additional 5 tons, 0·05 should be added to the factor 0·85.

24. *Diameter of Hauling Ropes.*—The diameter of the hauling rope depends upon the highest tension occurring in it.

Tension of rope in lbs.

$$= \left\{\text{initial tension} + \left(\frac{W}{S} \times H\right) + \left(w \times H\right)\right\} + \{(w \times \mu_1 \times N) + (L \times \mu_2 \times w) + (R \times 2)\}.$$

where W = weight of full carrier; S = spacing of carriers in feet; H = difference in level between stations in feet; w = weight per foot of hauling rope; μ_1 = coefficient of friction of cars; μ_2 = coefficient of friction for hauling rope; L = length of line in feet; N = number of carriers on one side of line; R = number of supporting rollers on one side of line.

This tension, if multiplied by the factor of safety—6 to 8—and divided by the breaking stress, gives the area of the rope necessary. This is for the general case with the drive at the upper terminal and the loads ascending. When the loads are descending, the plus sign in the centre of the formula becomes minus. To obtain the tension when the ropeway is just put into work, the second half of the formula should be doubled.

25. The usual breaking stresses of hauling ropes are from 80 to 115 tons per square inch. The surge of the hauling rope tension sheave depends upon distance apart of the carriers, long spans occurring in the line, etc. As an average, 6 ft. play may be allowed for to commence with, and then an additional 12 ft. for each mile of length. In some cases, in long lines it is necessary to split up the line into sections, to avoid excessive tensions occurring.

V. Ropes.

1. *Types.*—There are three main types of ropes used on aerial ropeways: (i) Lock coil and semi-lock coil; (ii) spirally-wound or helicoidal; (iii) stranded rope with Lang's lay.

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2. On the bicable system carrying ropes are generally of lock or semi-lock coil in the case of heavy installations, and spirally-wound in the case of lighter installations.

3. There are three types of lock or semi-lock coil rope, as shown in *Sketches* 2, 3 and 4.

The semi-lock coil consists of a spiral coil surrounded by a layer of round wires kept apart by wires drawn to a special section. Though with not quite so smooth a surface, it has the advantage of being cheaper.

4. The special advantages claimed for lock and semi-lock coil ropes are that :—

(*a*) there is minimum friction ;
(*b*) they have a longer life (Messrs. Spadaccini, an Italian firm, put it at 50 per cent. longer than that of stranded ropes) ;
(*c*) ropes are not deformed if one strand breaks ;—broken strands are liable to derail carriers.

5. The disadvantages are :—

(*a*) greater cost, at least 30 per cent. greater than spirally-wound ropes ;
(*b*) steel of maximum tensile strength cannot be employed in their manufacture ;
(*c*) cannot be spliced,—special sockets must be used for joining.

6. Spirally-wound ropes are cheaper than lock or semi-lock ropes and can be joined by splicing, and so are often used for lighter installations, as there is not much friction and they are better than stranded ropes with Lang's lay.

7. Stranded ropes with Lang's lay are used as carrying ropes when other types are not available, but with a hemp core they are nearly invariably used as hauling ropes.

8. Stranded ropes with ordinary lay are not used either as carrying or hauling ropes except as a last resort.

9. *Wear and Life of Rope.*—In the bicable system the wear to the carrying rope occurs on the top side of the ropes in spans, and on the bottom side in saddles ; and in addition, the vibration occurring in spans is damped down near saddles, causing fatigue in the wires. For this reason, to obtain the maximum life out of the carrying ropes, they must be shifted periodically and shortened at couplings so that positions of wear and fatigue may be changed.

10. In the monocable system the wear to the rope is distributed, and as the rope is continually passing round the terminal sheaves, inspection is easy, and a broken wire is easily detected and can be repaired before any damage is done. So, with the monocable system complete rope failure with efficient inspection is practically unheard-of, whereas even with the most careful inspection the carrying rope

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in the bicable system may fail completely, as it is very difficult to find out the state of the rope.

11. Italian experts attach great importance to the fact that in the monocable system the rope tends to revolve during its passage, but is prevented at the points where it is gripped by the carrier clips, and for this reason the life of the rope is very short. English experts, however, state that this has very little effect on the life of the rope, and point out that, if this was so, the same thing would happen to the hauling rope in the bicable system, which apparently is not the case.

12. Messrs. Spadaccini and other Italian firms estimate the life of lock and semi-lock coil rope at 12 years and of other types at about 8 years, when used on a bicable system, but put the life of a rope on a monocable system at about one year.

13. English firms, however, disagree and put the life of a rope in a monocable system at about two years, and of a lock-coil rope on a bicable system at about eight years. These figures are calculated on a basis of eight hours' work a day and 250 working days in a year, under peace conditions.

For war the above figures, showing the average life of a rope, should be halved.

14. The number of years a rope lasts is not altogether a true criterion of the life of a rope, as, in the case of a heavy installation the life of the rope is shorter, and the total tonnage moved must be taken into consideration.

15. It has been found that for locked-coil ropes a breaking stress of about 65 tons per sq. in. is about the best and for spiral ropes about 95 tons per sq. in. This is much the same as has been found by Italian firms, who state that the breaking strain of a rope in kilos is :—

In case of lock and semi-lock coil ropes—

number of wires × cross sectional area of a wire × 100.

In case of other ropes—

number of wires × cross sectional area of a wire × 150.

16. *Lubrication.*—The hauling rope of a bicable system and the rope of a monocable system are lubricated at the terminal sheave by some form of drip-feed, while to lubricate the carrying ropes of a bicable system it is either necessary to send a man standing in a carrier at a slow speed, or to use an automatic lubricating machine attached to a carrier, but the latter is not altogether satisfactory, as the lubrication is not under observation, although with large spans it is often necessary to use it.

17. A mixture of Swedish oil, tar, tallow and pine resin is often used for lubricating the ropes. The tar acts as a water-proofing agent.

18. *Splicing of Ropes.*—Lock and semi-lock coil ropes cannot be spliced, and for them special clips are necessary, examples of which are shown in the accompanying *Sketches* 5 and 6. The individual

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wires of the rope can be opened out and wedges driven in and a cap screwed on or molten lead run in. For all other ropes splicing is used. One Italian expert stated that they allowed one metre of splicing for each mm. in the diameter of the rope.

19. *Cost of Ropes.*—Post-war figures of the cost of ropes are not available, but ropes should only be bought from well-known wire rope and cable firms. Lock-coil ropes are the most expensive and are probably not less than 30 per cent. more expensive than spirally-wound ropes.

20. *The Relative Position of the Carrying and Hauling Ropes in the Bicable System.*—Some firms prefer the hauling rope above the carrying rope, as the type of coupling used is lighter and cheaper, and the length of the stations is shorter because the hauling rope may be led in and out of the jaws without interfering with the shunt rails.

21. But the overhead type of coupling has one great disadvantage when ascending a steep gradient, as the hauling rope reaction falls outside the wheel base, and this tends to make the carrier rock, and in some cases forces it off the carrying rope. In such cases the under-type grip should be used. Italian practice, as a whole, is in favour of the under-type coupling, while English practice prefers the over-head type, except on steep gradients.

22. *Varying Stresses Caused by Hauling Rope in the Bicable System when the Hauling Rope is Below the Carrying Rope.*—It sometimes happens at a trestle, on either side of which there are long spans, that there is a considerable downward pressure at the trestle caused by the hauling rope, and not only has the trestle itself to be strengthened, but in some cases the carrying rope, where it passes over the saddle, has to be protected by means of a steel plate cap, over which the carrier runs, as the pressure on the rope is greater than that allowed for. Some authorities recommend the use of a steel cap when the hauling rope reaction exceeds 450 lbs. per sq. in., but there is a difference of opinion whether steel caps are necessary or not.

23. An opposite reaction occurs at the centre of a long span, as the hauling rope tends to bear part of the weight of the carrier, and this makes the runners less secure on the carrying rope, and more liable to be blown off by high winds.

VI. Carriers.

1. These may be divided into:—(A) those used on a bicable system; (B) those used on a monocable system.

2. Taking the former (A) first, carriers may be divided into: (*a*) those employing screw grips depending on the weight of the load, and (*b*) those employing counter-weighted lever grips, each group being subdivided into those employing the overtype or the undertype grips.

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3. It is not proposed to give a detailed description of every type of carrier in use, but only to describe certain typical examples. The advantages and disadvantages of the overtype and undertype grips have already been discussed under "Ropes."

4. A carrier on the bicable system consists of three parts: (*a*) the runners; (*b*) the box or receptacle; (*c*) the hanging frame with coupling.

5. *Runners.*—The runners consist of one, two or four wheels deeply grooved which run along the carrying ropes. The usual runner has two wheels.

6. The running wheels should be of high quality steel, and the diameter of the wheels depends on the load, and type of rope. Larger wheels are required with spiral ropes than with lock-coil ropes.

7. The following table gives, according to one authority, average size of wheels for carriers with two wheels on lock-coil ropes.

Weight of load and carrier.	*Diameter of wheel.*
14 cwt.	8 inches
30 ,,	10 ,,
40 ,,	12 ,,

8. The wheels may or may not have ball bearings. Such bearings are said to reduce by one-third the traction power required, but their cost is double that of the ordinary type.

9. Italian firms state that on lines with small gradients where practically all the traction force is used in overcoming friction, the use of ball bearings is worth the extra cost, but that this is not the case on lines with steep gradients where the greater part of the traction force is used in raising the load. Whatever type is chosen, the runner pins should be self-oiling, to reduce friction as much as possible.

10. *Boxes or Receptacles.*—These are of various types and are made to suit the loads to be carried.

Common forms are:—(i) open wooden boxes with low sides; (ii) iron bucket pattern; (iii) long iron stretcher-shaped frames with wire-netting bottoms and sides.

11. Special single loads, such as baulks of timber or guns, are carried by using two sets of runners, to which the loads are slung by means of ropes.

12. *Couplings.*—The advantages of couplings employing counter-weighted lever grips are:—(*a*) the cost is much lower than those with screw grips depending on the load; (*b*) on small installations, where shunting devices are not used, the coupling and uncoupling can be done by hand without stopping the motor; (*c*) certainty of action and easy regulation of the grip on the hauling rope.

13. Their disadvantages are that they cannot be used on steep gradients or for very heavy loads.

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14. The coupling is actuated by the counter-weight lever which, as the load is pushed forward by hand along the shunting rail at the loading station, meets and bears against an inclined plane which turns the lever over one-third of a circle and forces the jaws to grip the rope. On reaching the unloading station it similarly meets an inclined plane which reverses the process. The jaws open and the carrier runs on to the shunt rail. The system is automatic and simple.

15. An example is shown in the accompanying *Sketch* 7.

16. Typical examples of couplings employing a screw grip depending on the load are shown by the "Ideal" couplings, made by Ceretti and Tanfani, and another form of coupling where the grip acts through a simple system of levers.

17. The "Ideal" coupling is actuated as follows (*vide Sketches* 8 and 9) :—When running on the carrying rope the weight of the carrier keeps the jaws of the grip closed. As the carrier reaches the unloading station the runners leave the carrying rope and are run along a shunt rail. As they do so, a wheel fixed at one side meets an inclined plane up which it is forced, and thus takes the weight off the runners, releases the jaws and moves the grip clear of the hauling rope.

18. To ensure that the runner wheels shall not rise from the shunt rail at the time when the side wheel engages the inclined plane, an upper guard rail is fixed to keep them in place.

19. The following are some of the advantages claimed by the makers for this type :—(*a*) simplicity, in that there are no levers or springs to weaken the device ; (*b*) by varying the slot the speed at which the grip is applied at the moment of starting can be regulated, sudden jar on the hauling rope can thus be avoided, and the life of the rope thereby lengthened ; (*c*) the force of the grip remains constant, whatever the gradient of the carrying rope ; this type is effective up to gradients of 1 in 1 (according to makers) ; (*d*) certainty of action.

20. In the second type the pressure of the grip is applied by the weight of the carrier and the load acting through a simple system of levers to give a multiplied pressure on the jaws. The grip is released by lifting the load, which is accomplished by means of small rollers running on to the shunt rails in the stations (*vide Sketch* 10).

21. Another type of coupling in which the grip is a function of the load is the "Vatellina" coupling, made by the B.B.B. firm (*vide Sketch* 11). The arrangement is as follows :—

22. The runner wheel has a hook below it. In this hook are two rings held together at the bottom by the eye of a second hook, in which hang the carrying chains.

23. The hauling rope passes between the rings, and the weight of the load forces the latter to grip it. This form of coupling cannot be used on the automatic system, as the hauling rope must be stopped

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when the carrier gets near the end of its run. It is therefore only suitable for short lines of small capacity.

24. It is cheap, simple and reliable, and a very convenient one for carrying long loads, such as guns, as two couplings can be used, one at each end.

25. In case the runner should jump off the carrying rope, a safety-chain is passed round the hauling rope and both ends are hooked through the ends of the supporting chains. In the case of a break of the carrying rope, the hauling rope would, within the limits of its strength, support the load.

26. In conjunction with this coupling a small clip is fixed on the hauling rope close to each grip as a further safeguard against slipping.

27. The B.B.B. make a speciality of a form of grip to reduce tensional friction both for the monocable and bicable systems.

28. The grip, which is actuated on the counter-weight principle, consists of a single roller which holds the rope against a jaw, or of two rollers which grip the rope between them; in either case the rope, though gripped, is allowed to rotate.

29. The grip has to be adjusted to each rope by means of packing pieces, a somewhat clumsy expedient. The design, however, overcomes what Italian firms call an important defect, especially of the monocable system.

30. This coupling was not seen at any of the installations visited, but the single roller and jaw type was said to have been largely used in the installations (bicable type) at Monte Pesubic, and to have been effective on gradients as steep as 4 in 5, and to be capable of taking loads up to 800 kilos, using a special heavy coupling.

31. Among the best-known couplings for the monocable system are Roe's patent Toggle and Saddle clips.

32. The clip, shown in *Sketch* 12, is capable of sustaining a load at an angle of about 45° and in theory is the most efficient of all clips actuated by the load, as the whole of the tare weight also is used for gripping. Another type, which is more usually employed, as it is cheaper, on gradients which do not exceed 1 in 2¼, is shown in *Sketch* 13.

33. The gripping in this type is performed by two cast chilled saddles, the sides of which are inclined, one side having a feather projection. It is so formed that it disengages itself without damaging the strands when the carrier enters a station.

34. A rough sketch of a type seen at an Austrian Installation at Matarello in the Trentino is given in *Sketch* 14.

When the wheel A is on the shunt rail it supports the carrier and the jaws are open. As it leaves the shunt rail the jaws are closed by the pressure of the cable on the two forked prongs at the mouth of the jaw.

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VII. Trestles.

1. Trestles can be of steel or wood, and may have one, two, three or four legs. Some typical examples are shown in *Sketches* 16 to 19.

2. Trestles are usually set in concrete, but this is not done in light portable installations. On the large lines it is the Italian practice to erect the trestles vertical, but on the lighter lines they prefer to have the trestles normal to the line of the rope, though this is not always done. When crossing a span it is important that the trestles should be adjusted to form equal angles with the rope on either side.

3. Trestles vary in height from a theoretical minimum of 2½ metres upwards.

4. In an aerial ropeway between Manizales, Columbia, and Mariquita over the Andes, there are eight steel trestles over 130 ft. in height, two of which are 217 ft. high.

5. Along ordinary ground of even grade the height is regulated by :—(*a*) the desirability of keeping the grade as even as possible ; (*b*) the headroom required in the centre of the span.

6. When there is a large difference of level between two points the line of the catenary is plotted on the profile, as already explained, and the heights of the standards regulated to suit this.

7. Some firms make standards which can be heightened by increments of one metre, but this is not universal and would be suitable only for light installations.

8. The chief point of interest in a trestle is the method by which it supports the carrying rope.

9. In the bicable system the carrying rope is supported in grooved fixed or oscillating saddles, whereas in the monocable system the rope is generally supported on revolving sheaves arranged in groups of two, four or eight according to the calculated pressure the trestle is expected to bear.

10. These sheaves are mounted on balance beams in such a way that each sheave takes its correct share of the pressure. Their use enables a trestle in a monocable line to take pressures which, in case of a bicable, would have to be met either by putting in an extra trestle or by providing rail supports. A monocable line may, therefore, be constructed with less trestling than a bicable, and thus save in material and expense. An example of a balance beam is shown in *Sketch* 1, and examples of trestles for a monocable line in *Sketches* 18 and 19.

11. In the bicable system pairs of saddles are employed where there is a great change of slope at any one trestle or where the pressure is more than one saddle can bear.

12. Oscillating saddles are as a rule preferred, and to save the wear on the ropes, the ends of the arms of the saddles are sometimes made of soft iron so that the saddle should wear and not the rope.

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13. In the bicable system the trestles are fitted with pulley wheels over which the endless hauling cable runs, and with guides to ensure that the hauling rope returns to its position on the pulley wheel after the carrier has passed. Examples of these are shown in *Sketches* 15 to 17.

14. To prevent wear of the hauling rope the pulleys are often fitted with removable soft iron treads which can be replaced when worn. This tread is a ring made in two sections which can be replaced without dismantling the complete pulley.

VIII. STATIONS.

1. Stations can be either :—(*a*) terminal stations for loading and unloading; (*b*) intermediate motor stations; (*c*) intermediate tension stations; (*d*) angle stations; or a combination of two of the above.

2. Stations on the bicable system are much bigger and more complicated affairs than on the monocable system, but the bicable has the advantage that, as the carriers are always gripped by the hauling rope, the working at stations where there is no unloading or loading can be made automatic.

3. On the monocable, however, when a carrier leaves the rope it must be pushed by hand, although the labour of pushing the carriers on the shunt rails can be minimized by grading the shunt rails.

4. *Shunt Rails.*—For a line to have any large capacity it is necessary to have some means of loading and unloading without having to stop the motor. This is done by the use of shunt rails on to which the carrier runs when it reaches the unloading station, and from which it is launched from the loading station.

5. Two small rollers are provided on one side of the coupling which are not in use when the load is on the carrying rope. On re-entering a station these two rollers run along the shunt rail, which is at a different angle to the carrying rope, and so take the weight of the carrier and at the same time allow the jaws of the grip of the coupling to open and disengage from the hauling rope. The carrier is then run along the shunt rail to some suitable place for unloading, or on to the next section of the ropeway.

6. Stations can be large closed-in buildings built with concrete and iron roofs, or small open buildings with some light form of roof. Some form of light roof is always provided.

7. *Driving Power.*—Various types of power can be utilized for driving a ropeway, such as petrol and electric motors, oil and steam engines, etc.

8. The amount necessary is obtained from the following formula :—
Power in ft. lbs.

$$= \left[\left(W_1 \times W_2 \times \mu_1 \times \frac{N}{2} \times V\right) + (w \times 2L \times \mu_2 \times V) + (2R \times V) + F\right]$$

+ or − theoretical power

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where W_1=weight of full carrier; W_2=weight of empty carrier; μ_1=coefficient of friction for cars; N=total number of cars on line; V=velocity in ft. per min. of cars; w=weight per ft. of hauling cable; L=length of line in ft.; μ_2=coefficient of friction for hauling cable; R=number of supporting pulleys; F=power required for station friction.

9. The first four factors give the power necessary to overcome friction, and the theoretical power required or developed depends upon whether loads are ascending or descending.

10. The factor for station friction varies greatly for different lines and is solely a matter of experience, although 0·02 of the total weight of the moving parts in the station multiplied by the speed may be taken as a good mean.

11. As already explained, some motors are fitted with a governing arrangement so that the speed of the hauling rope should not increase under a light load.

12. Special motors have been designed for light portable installations to work over lengths of 1 to 2½ kilometres with individual loads not exceeding 180 kilos, and spans not exceeding 250 metres, by Messrs. Spadaccini of Milan and Messrs. Badoni Bellari and Benazzoli of Lecco and Milan.

13. In permanent installations the motor is, as a rule, set in concrete. In light installations, however, the under-frame is often bedded into the ground for a few inches and filled with boulders, the motor itself being bolted to the under-frame and in some cases further steadied by sand-bags piled on the top of the upper-frame.

14. *Types of Tensioning Arrangements—Carrying Rope.*—The Italians and the Austrians tension the carrying ropes by hand-winch block and tackle, the strain being applied to the rope by a separate wire rope clipped on to it.

15. After getting the requisite tension, the rope is, in the case of light installations, made fast, either to the framework of the motor bed, or to some anchorage.

16. In the case of heavy lines it is made fast to a counter-weight. In Italian practice this counter-weight is usually a large box loaded with stone or other weighty material. The Austrians employ in their large installations counter-weights made up of layers of concrete segments which can be added as required to get the desired weight.

17. *Hauling Rope.*—On light lines tension is got by adjusting the distance between the driving and idle pulleys at the motor station by means of a wheel actuating a screw-threaded tension bar.

18. On heavy lines tension is applied by adjusting the idle pulley wheels at the tension station by block and tackle, and then either making fast to some anchorage or attaching a counter-weight, as in the case of carrying ropes.

19. If the station is not raised, a well must be dug to allow for the

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rise and fall of the counter-weight. In the case of the Austrian Installation at Calliano the passage of a light load was seen to cause a rise of 6 ft.

20. The tension of the carrying rope is generally about 3 to 4 tons per kilometre. That of the hauling rope is, of course, less.

21. An instrument for registering the tension is often provided.

22. *Framework of Stations.*—Both timber and steel are used, according to local conditions. The light Italian installations seen were mostly built of "L" steel.

A light roof as protection from the weather is always provided.

23. *Sketch* 20 shows an arrangement used by Ropeways, Ltd., which combines a multiplying and taking-up device. The two sheaves at A are attached to the tension trolley, the winch and the differential drum being mounted on an independent frame placed over the tension pit; one end of the rope B is anchored, the other being made fast to the tension winch drum. By this arrangement the resultant pull at A is four times the dead weight applied at C, and the weight can always be kept in suspension without the necessity of a deep pit by taking in the slack with the winch.

IX. Automatic Dumping.

One of the most common uses for ropeways in commercial work is the automatic dumping of refuse from mines.

Until recently the automatic dumping was possible only on the bicable system, but the principle has now been applied with success to the monocable. How this is carried out is shown in *Sketch* 19 of a monocable installation at Tredegar.

X. Fixed Clip Single Rope System.

1. This type of ropeway is only applicable for light capacities, and is used largely on plantations and for the transport of valuable ores, where comparatively small quantities are handled.

2. The carrier head, *Fig.* 21, is permanently attached to the rope by means of a spring steel strap, and is designed in such a way that it can pass freely over trestle sheaves, under depression wheels and round the terminals, without being detached from the rope. As both rope and carriers are in constant motion, loading has to be done by hand, or by means of a travelling hopper, which is usually hung from overhead rails at the terminal. The terminals are extremely simple and compact, as all shunt rails are done away with. The tension terminal is usually mounted on a trolly or on skids, the whole being movable by means of tension gear, to allow for stretch of rope, etc. Angles can be worked with the fixed clip system but they should be avoided if possible, as they tend to produce excessive rope and gear wear at such places.

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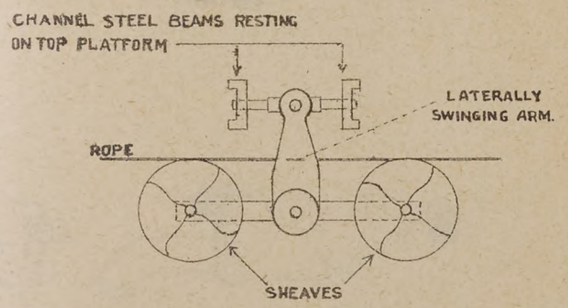

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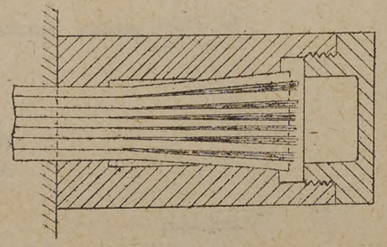

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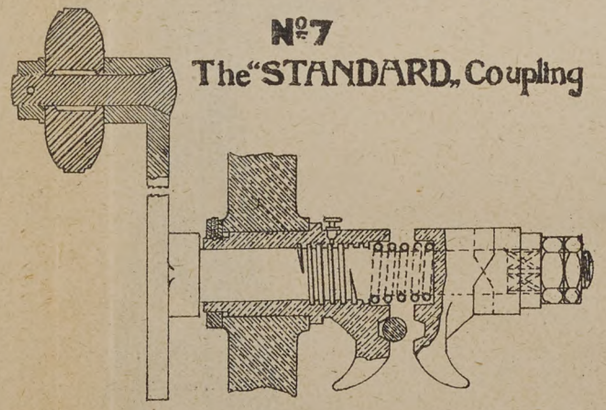

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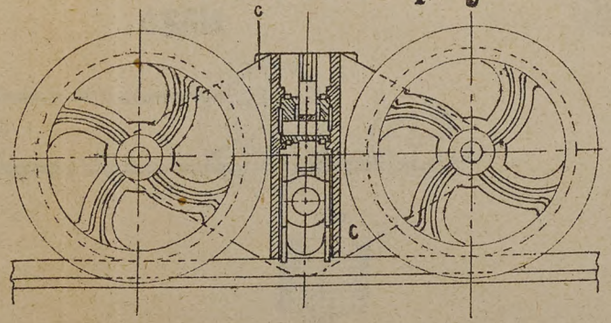

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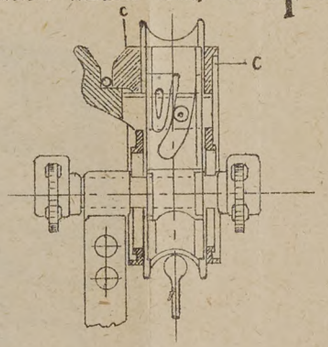

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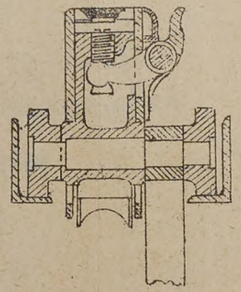

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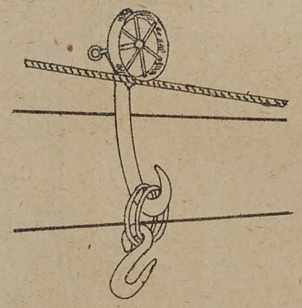

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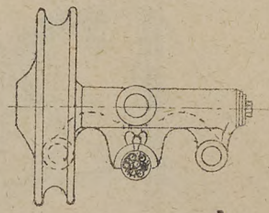

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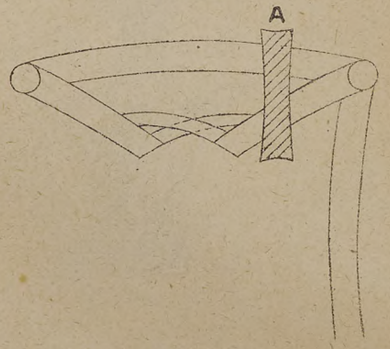

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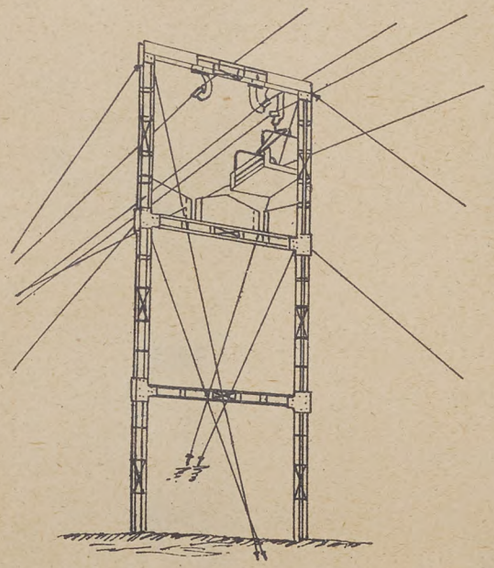

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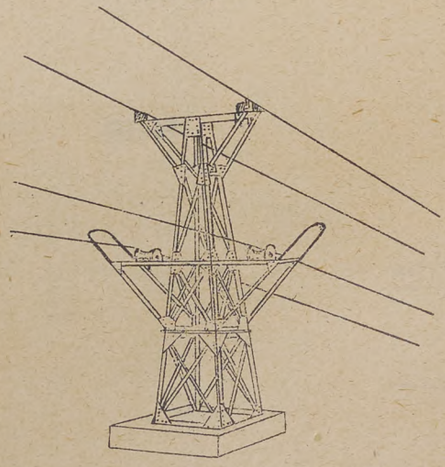

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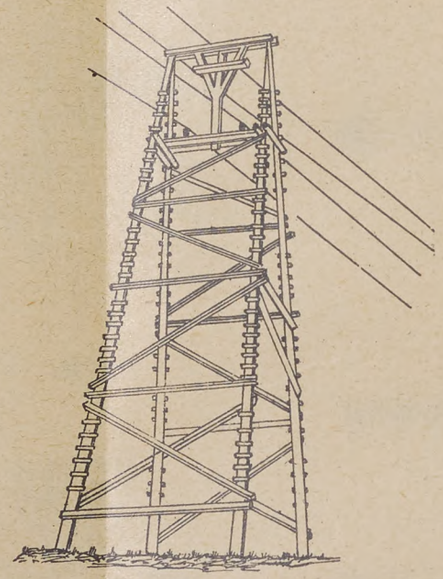

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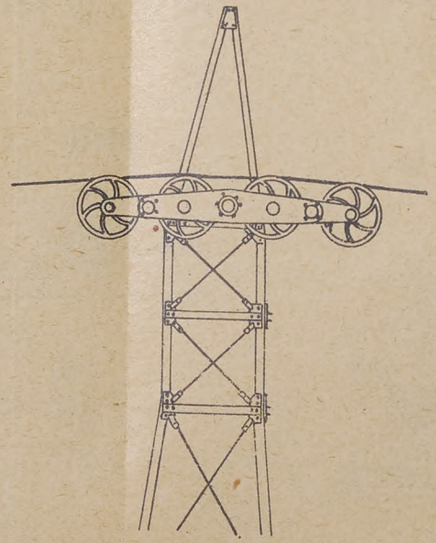

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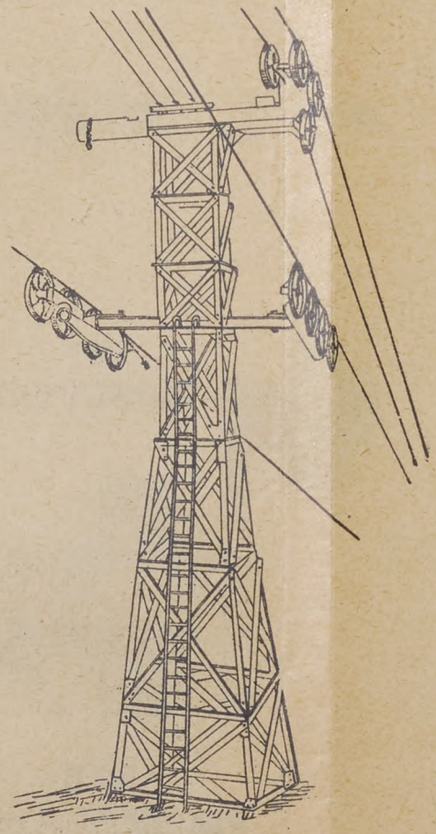

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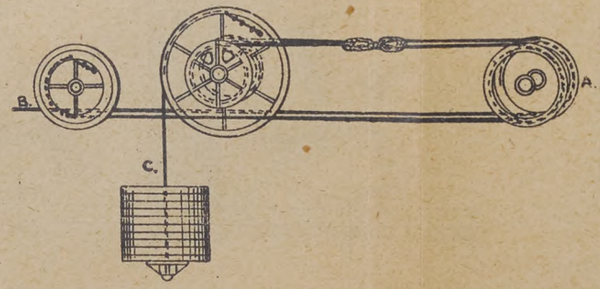

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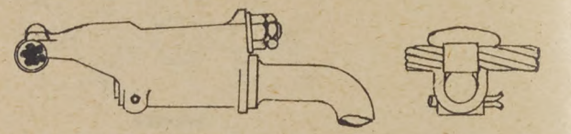

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This type of line is run at a slow speed, namely, about 200 ft. per minute, and the only advantages it can claim are its simplicity, adaptability to steep grades, and its low prime cost when light capacities and moderate lengths have to be dealt with.

XI. Jig-Back or To-and-Fro System.

1. This type of ropeway is useful for short distances, and is operated with a pair of carriers that travel in reverse directions and are loaded or brought to rest alternately at the opposite stations, but which do not pass round the terminals: it is, therefore, intermittent in its action, and the direction of travel is reversed after each journey. Where loads are to be carried which are heavy individually in relation to the capacity, and where the distance is short, the "To-and-Fro" system is particularly applicable. A high carrier and rope velocity may be adopted during the run, especially where a clear span occurs between terminals, and where there are no intermediate trestles.

2. These installations may be on the "Monocable" or "Bicable" principle, and in either case the moving rope is clamped to the carriers, and is not usually disconnected from them at the terminals.

3. It should be mentioned that, up to the present, the "To-and-Fro" ropeway is the only system that is used for regular passenger traffic, as the carriers lend themselves to the adoption of a safety grip used in conjunction with an auxiliary standing rope, but with such appliances these installations are very costly and present mechanical difficulties on lines of any length.

XII. Costs.

1. Post-war costs are not available, but as a general rule a bicable line is more costly in the first instance than a monocable.

2. The bicable has twice the length of rope that the monocable has, its carrier couplings are heavier and more complicated and its stations are larger, have heavier anchorages and involve much framework and foundation masonry.

3. The first cost of a bicable line is said to be generally about 20 per cent., but may be as much as 40 per cent. more than that of a monocable. As a general rule a bicable is considered by English firms to be more expensive to maintain than a monocable, but it is doubtful if Italian firms would agree to this.

4. There can be no doubt that in favourable circumstances with a well-designed ropeway there is a considerable saving in transport costs over other means of transport; and in many cases it is possible to construct a ropeway over ground over which it would not pay to construct a road railway, etc.

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XIII. METHOD OF ERECTION.

1. After the line has been surveyed, stations sited, and height and position of standards decided on, the work in the stations is started and standards erected.

2. Whenever possible, both carrying and hauling ropes and engines are taken to the upper station by tractor, etc. One of the carrying ropes is then unwound from the upper terminal, placed in the standards, tensioned, and used to help in unwinding the other carrying rope, and hauling rope downhill. These latter are then tensioned and erected.

3. Sometimes, however, it is difficult to carry up the heavy carrying ropes and motor. In this case the hauling rope only is taken up. It is then unwound downhill from the drum, placed in position on the standards, tensioned by a hand-winch placed round the terminal wheels, and used to haul up one carrying rope at a time by means of manual power applied to the hauling rope. Subsequently, when all these ropes are in position and tensioned, the motor is taken up in parts by means of the ropeway, operated by hand. Carriers loaded with stone on the down rope are used to help the motor up.

4. If there is no need, or if there are any other circumstances which prevent the transport of the ropes on their drums to the upper terminal, the hauling rope is carried up along the intended line by a file of men each carrying a portion of the rope in a small coil. When the hauling rope has been put in position, the carrying ropes are hauled up as already described.

5. The Italians seldom employ mules for carrying up ropes; if tractors cannot be used they prefer men. If, however, mules are employed they are loaded with a small coil. For a 20 mm. rope they would be spaced about 20 metres apart.

6. *Time Required for Erection.*—Italian technical officers state that 100 skilled men can erect and complete two kilometres of light line in ten days.

The transport and erection of the standards is the most difficult part of the work. This and the erection of the terminal stations take about six days. The ropes can be laid and tensioned in another four days.

XIV. TYPICAL INSTALLATIONS.

Italian Installations between Crespano and Mt. Grappa.

Type.—All the lines were of the 3-cable type and consisted of :— Two lines, Crespano (D) to Brusa Mosca (C), capacity 4 tons per hour each. One line, Brusa Mosca (C) to Conca Ardosetta (B), capacity 15 tons per hour. Two lines, Conca Ardosetta (B) to Mt. Grappa (A), capacity 6 tons per hour each. (*Sketch* 22).

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To feed the line C to B the lines D to C worked longer hours than the line C and B, and material was also brought to C by lorry.

A large amount of the material sent up was used near B and so only light lines were required from B to A.

Loads.—On lines B to C the carrier will take loads of 500 kilos, spaced at 300 metres. On other lines the carrier will take loads of 300 kilos, spaced at 200 metres. The largest single load sent up did not exceed 500 kilos.

Bends.—There is one change of direction of 50° at C.

Length.—The lengths of the various lines are as follows :—

D to C	...	1,675 metres	Total 5,880 metres
C to B	...	3,255 ,,	
B to A	...	950 ,,	

Section of Ground.—The following are the differences in level between the various stations :—

Between D and C	...	112 metres	Total 1,463 metres
,, C and B	...	1,033 ,,	
,, B and A	...	318 ,,	

The greatest span in the line DC = 275 metres horizontal
,, ,, ,, CB = 1,150 ,, ,,
,, ,, ,, BA = 645 ,, ,,

The steepest gradient in the line DC = negligible
,, ,, ,, CB = 4/7
,, ,, ,, BA = 2/3

Ropes.—All ropes were of steel wire of the following types :—

Carrying Ropes.

AB and CD ... 20 millimetres diam. hemp core Lang's lay.
BC ... 26 ,, ,, ,, ,, ,, ,,

Speed of hauling ropes on lines AB and CD ... 2 metres per sec.
,, ,, ,, ,, BC ... ... 2½ ,, ,,

Lubrication.—The lubrication of the carrying ropes was by automatic means and also by hand for the smaller lines. The hauling ropes were lubricated at one of the terminal stations.

Tension.—The tension for the carrying rope of the large line was obtained by the weight of a large wooden cylinder filled with stone and suspended over a pulley wheel.

Standards.—All standards were of steel. The different types used for the large and smaller lines are shown in *Sketches* 16 and 17.

The standards had concrete foundations and those for the light lines had wire guys.

The highest standard, one of those on the line BC, was 30 metres in height.

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The standards on the line BC were erected vertical, but the others were normal to the line.

Carriers.—Two types were met with, one of the bucket form of iron, and the other of the platform type of wood and iron.

The couplings used were made by Ceretti and Tanfani, and were of the automatic type where the grip depends on the weight of the carrier.

Motors.—Motors were installed :—

One at A
One at B } for lines A to B, each a 30 H.P. Lancia.
Two at C for lines D to C, both 30 H.P. Lancia.
and two at C for line C to B, one electric motor of 100 H.P., one Diesel motor of 120 H.P.

This allowed one spare motor for the large line.

Consumption.—For the Lancia motors, 3 litres of petrol per hour. For Diesel motor, 10–12 kilograms of heavy oil per hour. The electric motor took its current from a private company's mains.

Terminal Stations.—There is one large well-built station at C with closed sides, where the motors for the lines B to C and D to C are installed and the necessary shunting arrangements for transferring the loads from the lower lines to the big line, and *vice versa*, have been fitted.

There is also a large store-shed for spare carriers, ropes, parts, etc., at C.

Smaller stations have been built at D, B and A with all necessary shunting arrangements.

Personnel.—This can be shown under two headings :—

Operating party :—for large line (BC), 12 men.
for small lines, 6 men each.
Labour party :—for large line (BC), 20 men loading, 20 men unloading.
for small lines, 6 men loading, 6 men unloading

Cost—No information of practical value.

SHROPSHIRE MINES ROPEWAY, MINSTERLEY.

2. This line was completed in 1919. It is about 5½ miles long and is laid out to carry 20 tons per hour for barytes and 5 tons of anthracite (return traffic).

In 1919 the line was equipped (as regards buckets only) for half the capacity, as the mine had not yet reached its full capacity.

Curve.—A curve occurs in the line between points 13,910 and 16,612 ft. from the loading station.

Length of curve—901 yds.

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Angle between tangents—6° 43′. The curve is completed in 8 spans ; the deviation is about 1° on each trestle.

On the trestles in the curve the sheaves are mounted as usual on balance beams. The balance beam carrying the sheaves is suspended on a laterally swinging arm, which permits the beam and sheaves to swing outwards or inwards from the standards while the load passes (*vide Sketch* 1).

Thus any tendency for the ropes to mount the flanges of the sheaves, owing to change of direction, is obviated.

The wear on the sheaves is admitted to be slightly increased owing to the curve ; it is not great.

Loads.—5 cwt. (at present, line is carrying broken stone, which is lighter than barytes and loads are only about 4½ cwt.).

Speed.—At present 100 yds. a minute, will be increased later to 120 yds. a minute when the line has been running some time.

Motor.—Electric, 60 H.P., 3 phase, 500 volts, 726 R.P.M., 62·5 amperes per phase. 25 H.P. is sufficient to operate the line when full load is carried downhill.

Rope.—3⅛ in. circumference, stranded, Lang's lay. The whole rope has seven splices, each 40 yds. long. Weight of the heaviest of the continuous length as erected was 7 tons.

Lubrication.—At driving terminal by a drip feed from a tank.

Trestles.—Most of these are steel, but some are of wood. Steel trestles are three-legged and made of 90° "L" steel, compressed to 60° where the horizontal braces are fixed. Trestles are bolted throughout, and erected *in situ* in 2-metre stages.

Average height of trestles, 7–8 metres. Maximum height, 23 metres. Foundations, concrete block under each leg. Timber trestles, owing to local conditions, are cheaper in first cost for average heights. Trestles have pair beams or quads as required. Ball bearings are not used for sheaves. Total number of trestles, 75.

Carriers.—Bucket type.

Spacing.—98 yds.

Terminal Stations.—Loading terminal. Has motor as described, hoppers for loading, shunting arrangements for carriers, and tension arrangements for rope. Tension of rope—16 tons applied by a 4-ton concrete counter-weight through a 4 to 1 system.

The station is provided with a pair of bell spacers mounted together and driven by a chain off a sheave which revolves with the rope. The sounding of the first bell indicates the moment of approach of a carrier, and the second, the moment for launching one.

The arrangement is ingenious, but seems to be an unnecessary complication, the workmen preferring to space loads by eye.

Unloading (or return) Terminal.—Is a raised structure on steel framework with hoppers below for dumping barytes, and a raised hopper for loading anthracite for the return journey.

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Intermediate Unloading Station.—For unloading anthracite on the return journey. Requires no detailed description.

Erection of Line.—A length of 2,880 yds. of cable were drawn out from the drum fixed at the return terminal and erected on trestles in one length by 40 men (without horses) in 12 hours, the cable being hoisted by tackle on the trestle in turn.

Running Costs.—The line had been working too short a time to give complete working costs.

Loading station, 1 man for loading, 1 man for shunting and attending motor.

Unloading station, 1 man and 1 boy (exclusive of men working the shoots).

On line (including intermediate station), 2 boys.

Total, 3 men, 3 boys. Wages, £2 10s. a day, totalling £750 for a year of 300 days.

The total yearly capacity will be about 38,000 tons, and on the above,

labour costs work out at		4·75 pence per ton.
Power ... with coal at 40s. per ton, say,		4·5
Renewals ... stores (oil, grease, etc.) at $\frac{5}{8}$ths of a penny per ton per mile		3·75
		13·0

or a little over 2d. per ton per mile on the present reduced tonnage. The previous cost of transport by carts and tractors was about 19s. per ton or approximately 3s. per ton per mile.

DORADA ROPEWAY.

3. This installation is being supplied and constructed for the Dorada Railway (Ropeway Extension) Ltd., to join up the town of Manizales with rail-head at Mariquita in the Republic of Columbia, South America, and performs the duties of an ordinary light railway—excepting that no passengers are carried. The terminal and intermediate stations are arranged in warehouses or godowns where goods of all sorts—perishable and otherwise—are stored and delivered to or from the ropeway.

The ropeway will have a total length of 47 miles; at present 25 miles are in operation and the remainder of the length in course of construction. The supply of material for the completion of the line was held up during the war.

The 25 miles constructed have been running since 1915, and the venture shows a very substantial profit even on the tonnage at present dealt with—varying from 100 to 1,500 tons per month. This was likely to be greatly increased in 1919.

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The capacity of this line will eventually be 20 tons per hour of general produce from Manizales down to rail-head, and 10 tons per hour of general merchandise in the reverse direction.

At present the ropeway is equipped to carry 7½ tons per hour down from Manizales, and 3 tons per hour in the return direction.

Various types of carriers are employed suitable for the variety of loads which have to be handled, these varying from crates of china to light motor cars, and even occasionally a grand piano.

Present working costs, including stores, renewals and local administration charges, appear to work out at between 5d. and 6d. per ton per mile.

There will be 15 sections on this ropeway.

The power required is generated by Robey High-Speed Double Cylinder engines, placed generally at the divide-stations between sections, and developing 30 H.P. The boilers were supplied by Merryweather and Co., and are of the multi-tubular type with large fire-boxes for burning green wood or brushwood.

All parts of the power units were so sectionalized as to be easily conveyed by mules over the rough mountain paths—which provide the only alternative method of transport.

This type of power unit was decided on after very thorough consideration of all the questions involved, the original proposal being to instal a hydro-electric plant. Though ample water-power was available, the cost of the installation of such a plant was, however, considered and found to be excessive as compared with the power units decided on and supplied.

The power required by any section varies considerably in proportion to the loads being carried in either direction, and provision had to be made to meet all circumstances; for example, when loads were carried in both directions, or only from Manizales, or only in the reverse direction, and as some of the sections have a very considerable difference in level apart from the power unit—an automatic brake and regulating device had also to be supplied for such sections. This device takes the form of a hydraulic regulator, worked on much the same principles as a turbine, but so arranged that the speed can be varied and at the same time kept constant.

These regulators—though only 3-ft. diameter—are capable of absorbing anything from 5 to 40 B.H.P., allowing the ropeway to run at any speed between 100 and 150 yds. per minute.

It is believed that this is the first ropeway of its kind, *i.e.*, for the transport of ordinary merchandise between two towns, situated at a considerable distance apart, which has been constructed, and there seems an undoubted future for similar plants both in South America, India and other parts of the Globe.

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XV. AUTHOR'S NOTE.

The author is indebted to Colonel A. R. Winsloe, C.M.G., D.S.O., R.E., and Major E. W. C. Sandes, D.S.O., M.C., R.E., for certain notes on English practice and for descriptions of the Shropshire Mines Ropeway, Minsterley, and Dorada Ropeway, and to *Kempe's Engineers' Year Book for* 1920 for certain of the calculations and some extracts.

The following firms have very kindly supplied information to Colonel Winsloe, Major Sandes or to the author :—

Messrs. Ropeways, Ltd., of Eldon St., Finsbury Circus, London.
Messrs. British Ropeways, of 34, Fenchurch St., London.
Messrs. Luigi Spadaccini, of Milan.
Messrs. Ceretti Tanfani, of Milan.
Messrs. Badoni Bellani and Benazzoli, of Lecco and Milan.

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THE BUILDING OF A HOUSE IN N. RHODESIA.

By MAJOR J. KIGGELL, M.C. (late R.E.).

I ARRIVED on a farm in Northern Rhodesia in 1920 and lived in a C. I. hut with two small unburnt-brick rooms built on. To live in a tin hut in Africa is enough incentive to anyone to build a brick house.

There is no need to discuss the plan from the point of view of convenience of internal arrangement. Everyone has designed the ideal house ; but when it is going to be built by oneself these designs get very reduced both in frills and size. Suffice it to say that now it is finished we do not wish we had done anything different. While I am confident that it will be easy to criticize the design and methods of construction, it must be borne in mind that speed was essential, labour all very unskilled (or comparatively skilled in theory only !) and with farm produce selling at considerably below pre-war level one did not want to buy *anything*.

The first thing to do was to find suitable soil to make bricks with. My Construction School notes were consulted, and volunteered that a Stourbridge fire-brick contained 63·4 per cent of SiO_2 ; so I took a native to a spot near the site and water and asked him if that were good soil for bricks. He said it was. We made half a dozen bricks, adding in varying quantities of ant-heap and sand, and burnt them as a test. The soil was red loam and the bricks were very successful.

Brick moulds were made out of good packing case wood, bound with hoop-iron, three bricks to a mould. Allowing for shrinkage, we aimed at turning out bricks 9½ in. by 4½ in. by 3½ in., hoping not to notice the extra weight in the handling and giving about 17 per cent. less bricks to lay.

To make bricks here, one clears and smoothes about a quarter of an acre of ground, takes off the very top surface at one end and boys pick it up, pour water over it and tread it into *daga* (mud). This is dumped near a boy, the brick-maker, who is in a waist-deep hole. He slaps it into a mould, cuts off surplus *daga* with two sweeps of a stick, and it is carried off to another who turns out the bricks. The mould is brought back, washed (in another hole), sanded, and passed again to the brick-maker. The bricks are at once covered with grass.

All the books I have seen that mention brick-making under similar

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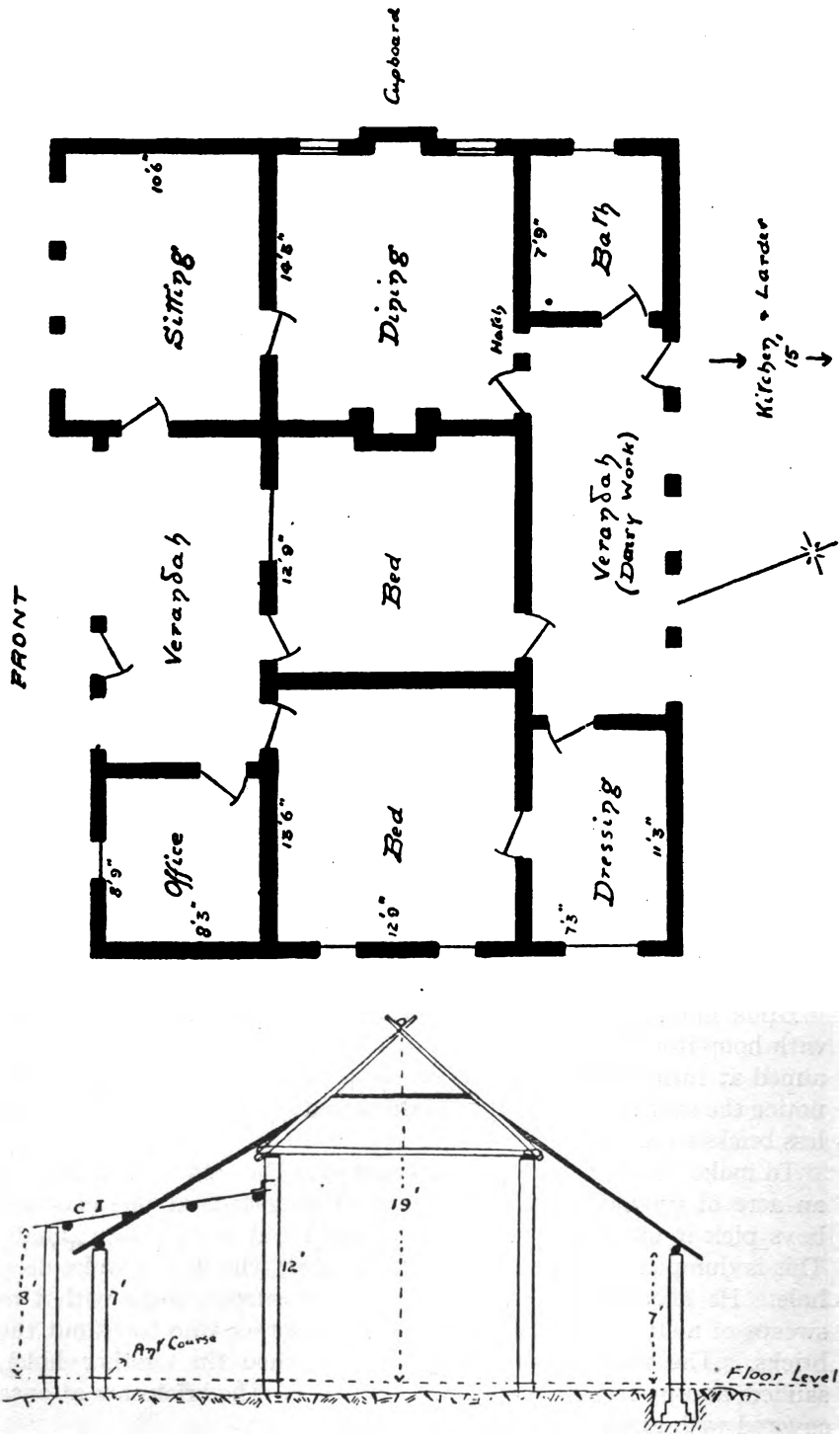

SKETCH I.—Plan and Elevation of House.

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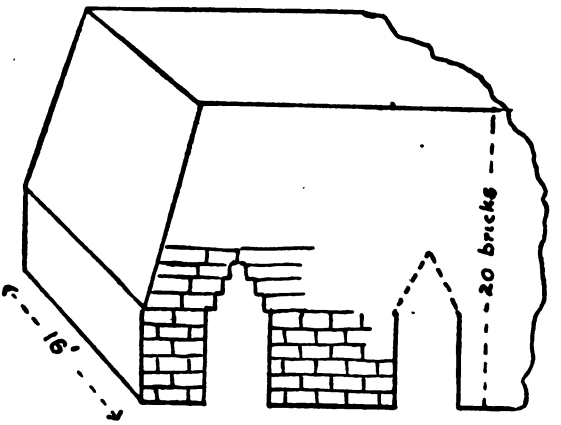
conditions advocate the boys standing on the ground and working to platforms. This seems rather unnecessary.

Eight boys can turn out a thousand bricks a day with ease. The bricks are turned on edge in two or three days—it is very difficult to persuade a boy merely to push the brick over on to its edge, instead of picking it up, turning it and putting it down again. Long before the ground is covered, the first bricks are dry enough to build into a kiln.



SKETCH II.—Brick Kiln.

They must be laid on edge in the kiln; because when originally turned out of the mould they take a slight curve according to the lack of regularity of the ground, and any weight put on the brick in this position, with no mortar underneath, would break it.

Trees are felled, green or dead, dragged up by oxen and sawn into handy logs. Twice as much wood is required as could be thought possible. The flues are stoked and lit and the ends closed with bricks, if one has remembered to leave any for the purpose. I do not know what one does otherwise—I have always remembered. The whole is then plastered with *daga*, recharged every five or six hours and burnt for four days and nights. Some people advocate putting six inches of kraal manure on top, and say that when that is burnt so are the bricks; but as I did not know just when manure can be called burnt—and do not now—we built a small kiln of 10,000 bricks first and burnt it for the mean time of all suggestions received. The kiln takes about a fortnight to cool.

Meanwhile the house had been pegged out and the foundations digged. Eighteen inches down we came to gravel and settled this was good enough. The last two or three inches had to be done by oneself, as the "water-in-a-stick" (or level) is more of a god than an instrument to the native. Even a fair native bricklayer will put his level against a leaning wall, slowly pull out the bottom until the bubble is central, and then go on with the next course entirely

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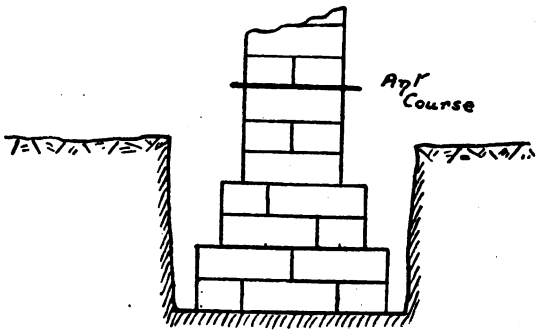
satisfied. The bottom of the trench was levelled off all round and wetted, and the first course laid straight on to it.



SKETCH III.—Foundations.

It was intended to build these in lime mortar; but through accidents and circumstances we finally built with *daga*, foundations and all. Other houses built similarly have been quite successful. When the footings were finished earth was well rammed all round them. I felt rather doubtful about these foundations, as all the houses near had them made of stone; but I knew a little about brick footings and nothing at all about working with stone, which would have had to be quarried and transported. Concrete would have been reassuring; but cement costs a pound a bag. Our only worry now is that what we did may be too good.

With this straight-ahead work, which would never be seen, it was soon found possible to lay a thousand bricks a day. However, out of consideration for Unions and my own hands, this was actually done only once.

At floor level came the job of putting down the ant-coursing. This is 26-gauge flat galvanized iron, cut into strips one foot wide, which are soldered or lapped together. It projects an inch or so both outside and inside the wall. It would not keep ants out of the walls, but as they cannot get through the iron they have to make a mud tunnel outside to get round it, and can thus be located and disappointed.

Door frames were made out of 3 in. by 2 in. native wood sawn up locally. We did order two from some big saw-mills at Livingstone. They cost a lot of money and were made in Sweden.

The courses kept pretty level. One would go and look at the walls from a distance, and having gloomily noted any special bumps would put rather less *daga* there for the next course or two. The next excitement was an arch over the fireplace. To save laboriously chipping and rubbing bricks, a wedge had been put in the bottom of one of the moulds and so we had some wedge-shaped bricks that were rubbed together to make a decent fit and only had a thin film

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of *daga* between them. It seems very difficult to make an arch that, once up, *can* collapse ; but strength was the only virtue of this one. Later on, when one had built arches over all the doors and windows, to save buying timber for a second top lintel, one used to show them to visitors.

From about five feet to seven feet I built the walls by standing on packing cases or on rough poles laid across them. Then we put up scaffold-poles of sorts with putlogs let into the wall and poles laid across them to stand upon. Everything was lashed with *intambo* of bark, soaked in water.

About then two boys arrived and asked for work as bricklayers. They only wanted fifteen shillings a month and were able to lay fairly well as long as the corners were put up for them. This gave us time to attend to one or two other things on the farm. By now we were quite determined not to make the walls any higher than necessary. You may design your bungalow to have 15-ft. walls ; but by the time you have laid ten of them you will be curious to see if twelve would not do. In this country a verandah is very necessary —for extra accommodation, coolness, and to keep the rain off the walls. It is a pity to make it less than 8 ft. wide and the front must be at least 6 ft. 6 in. high, or 7 ft., to allow for the overhang of thatch. The thatch must be at 45°, so the main walls of the house must be 15 ft. high. It seems incontestable ; but laying bricks must quicken the brain.

Having got the walls up to height, I left the bricklayers with the chimney and took a wagon off to find *mopani* wood. This is so hard that borers find difficulty in getting into it, and one thus avoids a gentle, but continuous, rain of wood-dust covering everything in the house, including lungs. Also it grows fairly straight, is very strong, and the heartwood is ant-proof in case of accidents. This was rather an interesting trip, as I did not know the country out that way (Kafue) at all, and had no idea where the *mopani* belt was. A guide I had arranged for failed to turn up, but I luckily discovered that another man had gone off to get wood some days before and that his wagon had a 5-in. tyre. We followed this spoor for over thirty miles, past the last farm and through a port in the Nega Nega Hills to near Kafue, where I found that the belt ran along the Kafue River. We camped there for two days and cut some quite nice poles. I came across plenty of game as this is really part of the Kafue Flats—zebra, koodoo, roan, lots of small buck, and rumours of lions ; but, after all, this article is supposed to be about a house.

Trusses were as simple as possible, as can be seen in the elevation. All nails had to be well started with an auger. Joints were bound with wire as well as nailed. The " leaners " or trusses at the ends were similar. (We hipped the roof back at the ends to allow for an

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all-round verandah and to save bricks. The hip rafters were made into a truss on the ground so that we could put them up quickly to stabilize the roof). Long poles were leant against the ends of the house and the trusses pushed and hauled up on to the roof where they lay flat with the tips supported by cross walls and poles.

We tied a long wire to the " leaner " and got it up to nearly vertical. With the only lashing on the farm we got the end truss vertical in position and then gently lowered the leaner down on to it.

It annoys me that this sounds so simple. *Mopani* is very heavy The labour available consisted of boys who were too frightened even to stand up on the walls and who had only the vaguest idea of what we were trying to do. Also they only imperfectly grasp what they are told to do in a sort of pidgin language of which they know about a hundred words all told and half of these refer to food.

However, having threatened each boy separately with death if he let go, I had now to climb to the top of this very insecure erection and join the two trusses, with auger and nail if they lay conveniently and with *intambo* if they did not. The long wire was made fast. Two similar trusses were put up at the other end. The centre truss was hauled up and held in position by two boys sitting on cross walls and holding the ends of the lashing clove-hitched to the apex. A long composite ridge of round poles, scarfed, and nailed, and wired together, was hauled up the side of the building, carried up the three rafters, rested in the V at the top and fixed there. One then felt much better. My complacency was disturbed by an exhausted voice, saying—" *Mina ifa* [' I die '], *Bwana !* " I looked round and saw a boy still grimly clinging on to the lashing of the centre truss, now quite firm. With much persuasion we made him slack it off, and his discomfiture—not at seeing that it was now unnecessary to hold it, but that to his mind he need never have held it at all—made his *confrères* laugh so much that one of them fell off and broke his arm.

Fortunately the other trusses swung into position and fitted all right. Under each one we put a small wall-plate of packing-case.

The main walls were only about 12 ft. high. To get an adequate pitch on the verandah rafters, these were adzed and nailed to the truss rafters, (*vide* elevation). This solved the problem of fixing them at their top-ends (as there was no wall-plate to speak of on this wall) and it allowed for circulation of air above the ceilings which makes a house so much cooler. Two purlins were put on as scaffolding to stand on and the whole roof was then wired parallel to these purlins—round and round, with boys on the ground straining on the wire as it was stapled to each rafter. Thatch, " cleaned grass," was tied straight on to the wires.

The sitting-room had to have a C. I. roof because of its pitch. Floors were made by laying half bricks, or well-rammed brick rubble, and covering with cement mortar on to which red oxide was sprinkled

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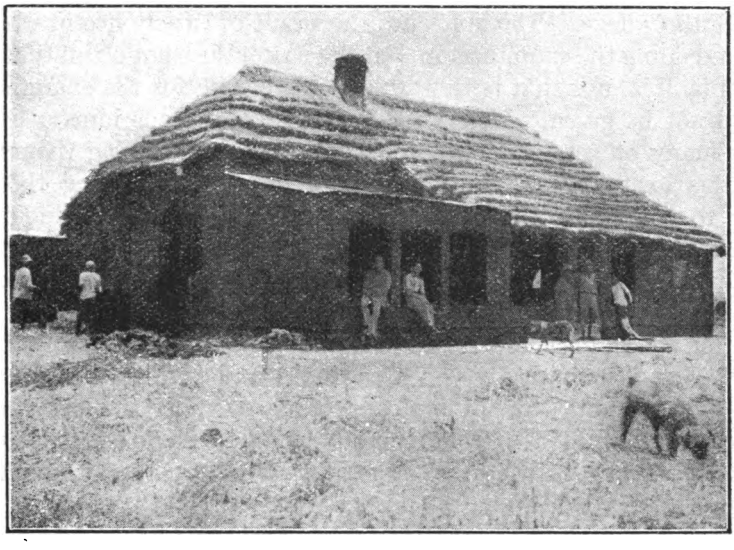
and trowelled in. If this is well done, the floor will take a polish and is of a comparatively agreeable colour. Walls plastered with *daga* and sand, whitewash and later sized and distempered, look very well. White *limbo* (calico) ceilings can be put up, stretched on laths and whitewashed to hide the joints. They look more like a pukka ceiling than one would believe, and cost about 17s. for a room 14 ft. by 12 ft. *Beaver Board* looks very little better and, of course, costs a good deal more here. It is well known what a lot can be done with brown paper as a foundation for a frieze.

The whole house and a detached kitchen and larder, from clearing the brick-field and including cost of native labour ; making, burning, carting and laying bricks ; cutting, carting and cleaning grass, etc. ; two doors and frames, and wood to make others ; wire, ant-coursing, cement, nails, lime, etc. (excluding only personal work, windows, and two doors we had before), was under £110.



The photograph shows the house unfinished ; the C. I. roof had grass mats laid on the top later, the thatch is unfinished and there is no mosquito gauze along the verandah, nor any front door ! Also it was all lime-washed.

I drove over and had lunch there yesterday. With flowers all round it, a tennis court, and a boy hurrying about with glasses and things on a tray, it seems extraordinary to me how like a house it is ; though it is such a short time since its constituents were just trees and grass and mud.

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NOTES ON WORKING FOR THE EXAMINATION FOR ADMISSION TO THE STAFF COLLEGE.

By CAPTAIN AND BT. MAJOR A. V. T. WAKELY, M.C., R.E.

PART I. GENERAL.

1. INTRODUCTION.

THESE notes are written with the object of assisting officers who intend to present themselves for the examination for admission to the Staff College. The notes are the result of experience in working for and doing the examination, but the writer does not claim that they are infallible, nor that better advice on working for the examination could not be given. His experience, however, leads him to believe that many officers waste valuable time when preparing themselves for this examination, firstly, through not fully realizing the best way to set about the work, and, secondly, through doing much unnecessary work. It is with the object of assisting the average officer who, alone and unaided, desires to prepare himself for the examination that these notes are written. Officers who are in a position to obtain expert advice and assistance may find below much that is unnecessary or superfluous and perhaps too detailed, but if these notes are of real assistance even to one or two less fortunately situated officers, their object will have been achieved.

Work should be begun at least a year before the examination. It may be divided into three parts :—

(1) Groundwork, from March to the middle of August ;
(2) Detailed preparation, from the middle of August to the middle of February ;
(3) Recapitulation, from the middle of February to the 1st March.

In these notes it is intended to give a brief outline of the groundwork necessary and to deal in detail with the various subjects under (2) above. Before doing so, it is advisable to discuss one or two points which apply generally to the whole work.

2. SELECTION OF OPTIONAL SUBJECTS.

To enter the Staff College by competition, it is absolutely essential to take three optional subjects. The choice of these is important,

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as it vitally affects the whole work. Assuming that French is taken, there is a choice of two other subjects. Referring now to *Staff College Regulations*, 1921, the following points should be borne in mind when selecting these two voluntary subjects :—

Languages (*b*).—If the candidate knows a second language *well*, he should take it ; the papers are fairly easy, but it would be hopeless to start a language afresh.

Principles of Business Organization and Administration (*c*).—This is an easy subject, but requires much reading and experience which officers are not likely to possess. On the other hand, the questions set are easy, and anyone who has a bent in this direction could easily do well in this paper.

Political Economy (*d*).—This is an easy and interesting subject, and the questions set are very fair. One object to be aimed at in selecting voluntary subjects is to choose one which will overlap the obligatory subjects. The one under discussion overlaps Imperial Organization and consequently has much to recommend it. This is, moreover, a subject of considerable practical value.

Elements of Engineering (*e*).—A fairly easy subject for an R.E. officer, but it necessitates rubbing up matter which one probably has not touched for years, and it does not overlap obligatory subjects. This is a distinct disadvantage. The difficulty is that the syllabus covers a wide range, and though one could easily answer at least two questions without doing any special work, the remaining questions necessitate much reading which is unproductive as far as the obligatory subjects are concerned.

Chemistry and Physics (*f*) and (*g*).—Not recommended for the average officer, because they do not overlap.

History of Europe and U.S.A. (*h*).—This is the most popular subject of all, and it overlaps Imperial Organization. The syllabus is very wide, however, and much reading is required. It is also difficult to get books giving sufficient detail, but on the other hand, the questions can be answered well without great detail, and a close study of detail would be a waste of time.

History of British India (*i*).—Much the same remarks apply as for (*h*) above. An easy subject for officers who have been in India, but otherwise it is hardly advisable to take it.

Movements by Road, Rail, etc. (*j*).—This is really the easiest subject of all, and the best one to take. The syllabus seems wide, but detail is not asked for in the questions, and there is one book which gives everything. The subject overlaps *both* Imperial Organization and Organization and Administration. This is one of the strongest arguments in favour of it. In this year's examination, three questions in Imperial Organization and two questions in Organization and Administration could have been answered on the candidate's reading

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for (*j*). These five questions were worth 1,100 marks. Further, the whole paper set for (*j*) could have been answered after reading a lecture given by a distinguished R.E. officer in the R.U.S.I. in November, and any officer who had served in France could have got at least half marks without doing any reading at all. A further argument is that this subject is a most valuable one, if not a vital one, for a Staff officer to study, and a knowledge of it will be of great value at the Staff College.

Mathematics (*k*).—Too difficult and does not overlap.

To summarize, (*j*) might easily take first place, and then either (*d*), (*h*) or (*i*), according to present knowledge and experience, choosing the one for which the least amount of reading will be required.

3. Assistance in Working for the Examination.

The syllabus for the examination is so wide, and such a great range of knowledge is required that the writer has been forced to the conclusion that some assistance is absolutely essential in working for the examination. This does not mean to say that it is necessary to employ a tutor; the writer's considered opinion is that it is not. On the other hand, any officer, however capable, who took the examination without having had his work criticized and directed into the proper channels would stand but a small chance of success. The object of getting assistance in the work should not be to obtain "crammed" knowledge, but to cultivate a good style, clear and concise expression, relevancy, and precision; not to obtain and learn by heart masses of detail, but to cultivate the power of forming and expressing an opinion on various problems, such opinions being based on a knowledge of the causes leading to such problems; and finally not to learn prepared answers to questions likely to be set, but to cultivate rapidity, accuracy and conciseness of expression, and to apply this to the particular problem under discussion to the exclusion of all irrelevant matter. It should be possible for every candidate for the examination to obtain the help of a senior officer or of an officer of the Army Educational Corps in correcting and criticizing papers. The candidate will then get another point of view; but let him first think out the problem and express his own point of view, then get another opinion. The reverse process is a mistake, and leads to "crammed" knowledge. The value of a tutor lies in the preparation of tactical schemes, but here again the assistance of another officer is more advantageous. It is a good scheme for two officers to work together at tactical schemes; the second officer may be going up for a promotion examination. One officer should set a scheme, both work it out independently, then compare results and discuss it. Discussion is more valuable than written criticisms as far as tactical schemes are concerned.

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4. GROUNDWORK.

The groundwork for the examination really extends over the whole of an officer's service, and in the examination all this knowledge has to be written down concisely, quickly and clearly. The gift of a fluent pen is therefore very desirable, if not essential in this examination. The reading of really good books and practice in writing will, however, develop power of expression. For the groundwork it is a good plan to devote about five months, beginning in March, to reading only. Practice in writing will be obtained later. Read a little and think a lot. Do not go too much into detail. The broad lines on which this reading might be tackled would be as under :—

(*a*) *Training for War.*—Chiefly strategical. Read *F.S.R.*, Vol. II (1920) Chapter I, and learn the principles. Then read *Military History* and think out examples of the successful and unsuccessful applications of those principles. Of course, questions can be set on any campaign, but 1914–18 is by far the most important. The following books are suggested for reading during the groundwork period.

The Science of War ... ... HENDERSON.
The Direction of War ... ... BIRD.

It is well to begin the more or less detailed study of campaigns now, and the following campaigns are suggested :—

1914–18 in France (especially first two months and last four months) ;
1915–18 in Mesopotamia ;
1915–18 in Palestine ;
1805 Ulm ;
1806, Jena ;
1815, Waterloo ;
1861–64, Shenandoah Valley.

These do not require to be studied in great detail, but the point is to bring out the application of the principles of war and know definite examples of their application. For the tactical side of this subject it is well to read the more important parts of the new Training Manuals, *e.g.*, *F.S. Regs.*, Vol. II (1920) Chapter III and VIII to XI.

The question of training should not be neglected, and *Infantry Training*, Vol. I, should be read.

(*b*) *Organization and Administration.*—Very little can be done in this subject as regards reading, as there are no books on it. The history of the British Army may be studied in *Outline of the Development of the British Army up to* 1914 (Major-General Anderson).

The *Army Quarterly* and the *R.U.S.I. Journal* should be read.

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(*c*) *Imperial Organization.*—This will probably be a more or less new subject to most officers. The reading should aim at getting hold of the broad facts and principles.

The best books are :—

The British Empire, Past, Present and Future ... POLLARD.
Foundation and Growth of the British Empire J. H. WILLIAMSON.
The British Empire ... ... LUCAS.
The Government of the British Empire ... ... JENKS.
Naval and Military Geography of the British Empire
Dr. VAUGHAN CORNISH.
Outlines of Military Geography ... ... MACDONNELL.

Get the *Times* daily, and read all important articles.

5. PROMOTION EXAMINATION. (*d*).

Many officers take (*d*) for promotion in October for experience in examination work, and the scheme is a good one. A study of 1914 is required for (*d*), and this is useful, but on the whole the writer is inclined to think (*d*) a waste of time. The knowledge required for it is more elementary, and an officer would necessarily have to spend much time on detail of administration, etc. ; otherwise there would be a risk of failing in (*d*) and the moral effect of that would be distinctly bad.

6. BOOKS.

The supply of books and papers must be properly organized. They divide themselves into three catagories :—

(1) Library Books ;
(2) Books and Reports, costing not more than 3/- or 4/- each ;
(3) The Press.

As regards (1), most officers should have two sources of supply : the Garrison Library and his own Corps Library. For R.E. officers, the Corps Library, as far as its funds admit, will buy any book recommended ; the difficulty is that there is a great demand for these books and one cannot usually keep them more than a fortnight ; but the Library will occasionally get two or more copies if necessary.

The small books must be bought, but money spent in this way is well invested. It is best and quickest to get all books through one publisher. The undernamed are very good, and will find and get any publications required :—

Messrs. SIFTON PRAED & CO., LTD.
67, St. James's Street,
London, S.W.1.

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They keep a special bookshelf for the Staff College examination, and it is worth while paying a visit to their place. Official publications divide themselves into two kinds—War Office publications and those issued to the public through the Stationery Office.

The former can always be obtained from Official sources. The great difficulty with the latter is to find out what is published. Sifton Praed have a list which can be consulted in London. It is worth having a look at this, as the Stationery Office publications are a most valuable source of information, and the price is seldom more than 1/6 each, *e.g.*, *Esher Committee Report on Indian Army*; *Montagu-Chelmsford Report*, &c., &c. It is well worth while becoming a member of the Royal United Service Institution. The entrance fee is £1 1s. 0d., and annual subscription, £1 1s. 0d. The *R.U.S.I. Journal* publishes all the lectures given at this Institution.

For notes on the Daily Press, see para. 4, part II.

In the lists of books recommended below the letters in brackets in front of the titles of the books refer to the following :—

E. = Very good book and essential to read ;
G. = Good book, but not absolutely essential ;
L. = Library Book ;
R. = Reference book to be bought and kept.

PART II.

Detailed Preparation.

The detailed preparation for the examination will now be considered. The work must be properly and systematically organized, otherwise one does not get a true perspective of the syllabus and many important matters may be overlooked.

1.

The first question to decide is the amount of time available. This depends on how fully one is employed by one's ordinary work during the day, and must be governed by individual circumstances. *At least* 24 hours per week should be devoted to the Staff College work, and it is better to aim at 33 hours per week. Opportunities occur for Staff College work in one's daily duty and should not be missed. If one is unfortunate enough to be fully employed at one's ordinary work for nine or ten hours a day, it is a good plan to take a month's leave previous to the examination, as a month's solid work is more valuable than the odd ends of days one can devote under these circumstances while on duty.

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2. Division of Time.

The next essential is to divide up the available time between the various subjects, more or less on a basis of mark value. The tendency is to spend too much time on the most interesting subject, *viz.*, Imperial Organization. Assuming that 33 hours a week can be devoted to the work, make out a time-table something like that shown below. There are 11,000 marks for the examination, so each 1,000 marks is worth three hours a week.

On the other hand, if only three hours a week is spent on French, it will not be much good, and a loss of marks here would, in a competitive examination, be more serious than the corresponding potential gain in marks which extra time spent on Training for War would give. The same argument applies to other subjects.

Suggested Time-Table.

Day.	Training for War.	Organ. and Admin.	Imperial Organi-zation.	French.	Opt. Subj. Strong.	Opt. Subj. Weak.	Total Hours.
Sunday ...	1½	2	—	1½	—	—	5
Monday ...	1½	1½	2	—	—	—	5
Tuesday ...	3	—	—	1	1	—	5
Wednesday	—	2	2	—	—	1	5
Thursday ...	1½	—	—	1	1	1½	5
Friday ...	—	1½	2	—	—	1½	5
Saturday ...	1½	—	—	1½	—	—	3
Total Hours	9	7	6	5	2	4	33

If the total time available per week is less than 33 hours, the time given above for the various subjects should be reduced in proportion. This Time-table should be modified about every month as progress is made, the tendency should be to *increase* the time given for Training for War up to 12 hours per week, *i.e.*, its mark value.

It is important to keep to the time-table, tick off each day the time spent on the various subjects. On Monday, say, one might spend five hours at Training for War, but the total at the end of the week should agree with the table.

3. Note-Books.

It is of great value to keep a note-book for each subject, so get six "Army Books, 129s" or similar books. Everything of importance should go into these books, and they will constitute a valuable stock of information to read up just before and during the examination.

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It is *essential* to *index* them as each series of notes is entered in the book, otherwise much time is wasted later on searching for some particular subject. Cuttings out of newspapers should go into these books. The best way to make up these notes is not to slavishly copy out articles and papers. Read the article over twice, the second time very carefully, then putting the article aside, on a rough piece of paper put down the headings, and write in the note-book a *précis* of the article. This fixes the facts and arguments in one's memory much better than anything else. It will be found in the examination that, if a question is given on something dealt with in this way, even after a lapse of two or three months the facts and arguments come back without the least effort.

4. The Daily Press.

The *Times* is undoubtedly the best paper to read; it gives more news than any other daily paper. The best way to deal with it is to look it through carefully *every day* and cut out important articles and stick them in the note-book dealing with the subject. Do not cut out too many articles, there will not be time to read them and they only fill up the book. Do not cut out articles on *undeveloped* situations, these are not of much value. Cut out articles on Military subjects and the debates in Parliament on Naval, Military and Air Force Estimates. These give valuable indications of Military policy. It is a mistake to spend much time reading and trying to understand a complicated article on a subject not previously studied. Put the article in the note-book and refer to it later on when the essential groundwork of the problem has been mastered. For example, it is not every officer who knows exactly the difference between an Executive Council and a Legislative Council, and it is positively a waste of time to try to understand an article on Colonial Government without first reading the chapters in either Lucas or Jenks dealing with it. Then, having mastered the essential features, read the article, perhaps two or three months after it appeared in the *Times*, and *mark in red* the important points. Marking these makes it easier, just before the examination, to rub up facts without wading through much small print.

5. Training for War.

Turning now to the separate subjects, "Training for War" is by far the most important.

It divides itself into three parts:—

(*a*) Strategy;
(*b*) Tactics;
(*c*) Training.

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(*a*) *Strategy*.—However interesting and instructive it may be, much reading of books on strategy is a mistake for two reasons—firstly, it is very difficult to read a great deal and to retain what is read; and, secondly, such reading takes time, which is not available.

The groundwork reading of Military History should give a fairly good idea of strategy and the principles of war, and during the period of detailed preparation for the examination it is well to work up a few examples from the campaigns studied. The method of working up these examples is important. The writer considers that the best method is first to read up some particular operation or series of operations; then think out what principles of war were involved, what information did the commander have on which to base his plan? was his plan in accordance with the principles of war? were any principles violated or neglected? was the operation successful or not? what were the reasons for success or failure? did the commander adopt any new methods of applying the principles of war, &c.? The student should think out these problems for himself, after reading the narrative of the campaign. Then see what General Bird has to say on the problem under discussion. Compare the points thought of with those mentioned by General Bird.

Again, compare the operations of one commander with those of another; *e.g.*, how does the German plan in 1914 compare with that of Napoleon at the opening of the 1815 campaign? There are many points of similarity as regards principles, though the conditions are, of course, vastly different. It is a great mistake to read Clausewitz, Hamley, Foch, Bernhardi, &c., from cover to cover. Read less and think more. Also, it is a good plan to get a senior officer or anyone who is willing to help to set some questions on strategy, such as Question 2, 3rd Paper, *Training for War*, 1921; and Question 1, 2nd Paper, 1922. Do these questions properly and get them criticized.

(b) *Tactics*.—The tactical schemes are by far the most important part of the whole work. In the 1922 examination they carried 3,250 marks. It is utterly useless to go up for the examination, unless some hard work is put in at these schemes. Some people do them automatically, but the average officer, even given much fighting experience, is not altogether at home when confronted with a map and a book of narrative. Rapidity is essential. Schemes must be fully worked out against time. For a suggested method of setting schemes, see Part I, para. (4) above. It is most important to discuss the schemes or to get them criticized. The following should be dealt with:—

Advanced Guard, Rear Guard, Encounter Attack, Outposts, Outpost Zone, Defensive Position, Flank Guard, Marches, Mountain Warfare, Bush Warfare and Desert Warfare, Convoys, Position

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Warfare—Counter Attack, Position Warfare—Raids, Ammunition Supply, Supplies, Evacuation of Wounded, Inter-communication, Guerilla Warfare and Drives.

There are here 18 different schemes. *At least* one scheme a week should be worked, using different kinds of maps. It is useless to read through a scheme set in previous examinations and say the solution would be this or that. The schemes must be worked against time, but at first *with the help of F.S.R. and notes*, so take about an hour longer than examination time until proficiency is attained. Then in the last two months or so, work several under examination conditions. There is a great variety, but it is extraordinary how similar several of the solutions are. Generally speaking, work with an Infantry Brigade Group and Cavalry both attached and independent.

(c) *Training.*—It is a sound scheme to spend a fortnight with an infantry battalion if possible and see what they do. If this can be done, get hold of their training programme for the season, and work out the why and the wherefore. The sequence of training operations is important, and the various things done in each period.

Bibliography.—

(E L) The Direction of War.—*Major-General Bird.*
(E L) The Science of War.—*Colonel Henderson.*
(G L) The Operations of War.—*Hamley.*
(G L) The Principles of War.—*Foch.* (Use the French edition.)
(E L) Stonewall Jackson.—*Henderson.*
(E L) Forty Days in 1914.—*Maurice.*
(G L) Napoleon and Waterloo (2 vols.).—*Becke.*
(G) Waziristan, 1919–20.—*Official.*
(E L) Small Wars.—*Callwell.*
(E L) The Last Four Months.—*Maurice.*
(E L) Story of the 4th Army.—*Montgomery.*
(G L) Battle of the Marne.—*Perris.*
(G L) French's Dispatches.
(G L) Haig's Dispatches.
(E R) Notes on Infantry Tactics and Training.—*Sir G. M. Harper.*
(E R) F.S.R., Vol. II (1920).
(E R) Infantry Training, Vols. I and II.
(E R) Artillery Training, Vol. III.
(E R) Armoured Car Training, 1921.
(E R) Cavalry Training, 1920.
(E R) Tank Training, Vol. I.
(E R) The Division in Attack, SS 135.
(E R) Artillery Notes No. 4.
(E R) Platoon Training.
(E R) The Division in Defence, SS 210.
(E R) Signal Training, Part VIII (provisional).
(E R) *R.U.S.I. Journal.*
(E R) *Army Quarterly.*
(E R) Report on Examination for Admission to Staff College, 1921.
(E R) Report on Examination for Admission to Staff College, 1922.
(G R) Report on Examination for Promotion, 1920.
(G R) Report on Examination for Promotion, 1921.

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6. ORGANIZATION AND ADMINISTRATION.

This is a most difficult subject to deal with, because there are no books whatever on it. The pre-war books are worse than useless, as they are out of date, and they deal with facts rather than problems, though Collin's book is useful for reference.

A good scheme is to write down all the problems which may form the subject of a question. This does not mean that prepared answers are to be learnt by heart, but such a list should rather give a basis upon which to work up the whole subject. Think out the various problems, and find out the causes which led to the change of organization, or, for future problems, find out what are the arguments for and against certain proposals. The mere discussion of these problems will give rise to others. Discuss them with other officers who may be working for Staff College or promotion, or with senior officers, and make them the subject of an essay in the Organization and Administration note-book. There are sound reasons for every change in military organization, and every fresh change must be carefully considered before it is adopted. Think out these reasons in each case, apply them to past history and future requirements. The whole subject of Organization and Administration requires thought and reasoning rather than much reading. The following are a few suggested subjects for discussion :—

Action in aid of the Civil Power, Cost Accounting, Cavalry and Tanks, Cavalry and Aircraft, C.I.D., Co-operation with the Dominions in Military Organization, Clothing Allowances—New Scheme, Conscription *v.* Voluntary Army, Divisions of U.K. for Administration, Dominion Armies (see *F.S.P.B.*, and bring it up to date), Demobilization, Defence Ministry—Arguments for, Daily Messing Account, Educational Training, Expansion of Regular Army in War, Foreign Armies, Geddes Economy Report—Effect of Reduction, Headquarters Units, Indian Army Reform, Linked Battalions and Depôts—Draft Finding, Mobilization, Mechanicalization of the Army, Officer i/c Records, Recruiting during the War and at Present, Reorganization of the various arms (post-war), Recreational Training, Regimental Paymaster, Territorial Army, Terms of Enlistment—Reserve and Colour Service, The highest self-contained tactical unit—Brigade or Division, Two Brigades *v.* Three Brigades, Four Companies *v.* Eight Companies, Battalion Guns, Transfer Act during the War, Traffic Control, Divisional Control *v.* Brigade Control for M.G.'s, T.M.'s, &c., Brigade Control *v.* Battalion Control for M.G.'s, T.M.'s, &c., Transportation Organization in France, Organization of Sea Transport, and so on, *ad infinitum*.

The best sources of information on these subjects are the *Army Quarterly* and the *R.U.S.I. Journal*; the articles in these periodicals touch on most problems, except perhaps those which are apparently too simple and well-known to need mention, but which one finds

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one knows nothing about when it comes to putting cold facts on paper, *e.g.* :—Which is the better plan, to provide drafts for abroad from the linked battalions at home, or from the depôt direct ? There are strong arguments in favour of each plan.

The History of the British Army has not been included in above, as Major-General Anderson's book gives a very clear account and is very valuable.

There are several questions in " Organization and Administration " on Military Law. It is very important to get *M.M.L.* and *K.R.'s amended up to date.* Stationery Office issue amendments periodically. Note that no question is asked in the examination on matters published less than six months before the examination. The questions carry only low marks, but it is worth while working out a few examples so as to get to know the way about these books.

Bibliography.—

(E L) Military Organization and Administration.—*G. R. N. Collins.*
(E R) Outline of the Development of the British Army up to 1914.—*General Anderson.*
(G L) The Body and Soul of an Army.—*Sir Ian Hamilton.*
(E R) Statesman's Year Book.
(E R) *Army Quarterly.*
(E R) *R.U.S.I. Journal.*
(E R) M. M. L.
(E R) K. R.
(E R) T. F. Regulations.
(E R) Esher Committee Report on Indian Army.
(G R) Geddes Committee Report, Part I.
(E R) F.S.R.'s, Part II.
(E R) F. S. P. B.

Imperial Organization.

This is the easiest and most interesting subject of the obligatory ones, but avoid spending too much time at it. The best way is to lecture to N.C.O.'s and men on it. The 2nd Class Certificate of Education includes a good proportion of what is required and the instructor can choose his own syllabus.

Write out the lectures, it gives very good practice, and write them out more fully than is necessary for the delivery of them. It is not necessary to give the complete lecture to the men ; it would be beyond their requirements, but it should be possible to get the lectures criticized by an officer of the A.E.C. Of course, further reading must be done for this subject, and the object aimed at should be to get a thorough grasp of the main principles of Imperial Organization and to think out the problems now confronting us, both within the Empire, and as regards foreign policy.

A good atlas is essential. The *Times* Atlas is the best, but it is bulky and heavy. *The Comparative Atlas* (Meiklejohn, price 4/6) is handy, and though it does not give much detail, is useful when reading articles in the Press.

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It is not a good scheme to concentrate on one or two colonies and learn everything about them, for two reasons: firstly—too much detail will be learnt; and, secondly, the question in the examination is more likely to deal with a general problem.

There is no short cut for this subject; it is essential to read the best books and to think out the problems oneself. On the 1st of each month the *Times* reviews the monthly magazines, and there are often very useful articles in some of them. These can usually be seen in any club, and it is hardly necessary to buy the magazines. *The Round Table* is a quarterly review (5/-), and is excellent for current Imperial questions.

Bibliography.—

(E L) British Empire; Past, Present and Future.—*Pollard.* (Groundwork of history up to 1907.)
(E L) Foundation and Growth of the British Empire.—*J. A. Williamson.* (Elementary.)
(E L) The Government of the British Empire.—*Jenks.*
(G L) Expansion of the British Empire.—*Woodward.*
(E L) The British Empire.—*Sir C. Lucas.*
(E L) Rise and Expansion of British Dominions in India.—*Sir A. C. Lyall.*
(E L) Influence of Sea-Power upon History.—*Mahan.* (First part only.)
(E R) Frontiers.—*Fawcett.*
(E R) Imperial Military Geography (a lecture).—*Vaughan Cornish.* (1/-.)
(E L) Imperial Military Geography.—*J. Fitzgerald Lee.*
(G L) Outlines of Military Geography.—*Macdonnell.*
(G L) Britain and the British Seas.—*Mackinder.*
(E L) The Future of the Empire, 1918.—*Mills.*
(E L) Seaways of Empire.—*Sargent.*
(E L) Sea-Power in the Pacific.—*Bywater.*
(G L) The Truth about China and Japan.—*Putnam Weale.*
(E R) Statesman's Year Book.
(E R) *Army Quarterly.*
(E R) *The Round Table.*—5/-, quarterly.
(G R) Summary of Proceedings of Imperial Conference, 1921 (Comd. 1474), 9d.
(G L) Imperial Defence, 1903.—May. (Out of date, but useful.)
(G R) *Aeronautical Journal.*
(E R) *R.U.S.I. Journal.*
Magazines: *Fortnightly Review, Contemporary Review, Nineteenth Century,* &c., when suitable articles appear.
(E) Comparative Atlas.
(E) The *Times.*

8. FRENCH.

The standard is very high in French, but there is not much difficulty, given a previous knowledge of French. It is a waste of time to go to France especially to study French for the examination, as there is no oral examination, and one would never in ordinary conversation hear the military words required in the examination.

The best scheme is first to go carefully through *Hugo's French*

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Simplified and make absolutely certain of all the grammar, if one is not already an expert French scholar. Then do translations and essays. Select pieces for translation from *F.S.R.*, *Army Quarterly*, etc., and other books. Translate them, and get them corrected by a Frenchman if possible. The present writer can give any officer the address of a Frenchman who will help for a small fee, and who takes much trouble.

These translations are very difficult, but the examination papers are very difficult, and unless one does some beforehand one has no chance in the examination. It is very important to write essays on military subjects, and these exercises can well be combined with the obligatory subjects. Always use a *French* dictionary, *i.e.*, one written in French whenever possible, and only look up an English-French dictionary when one is absolutely stuck for the word. Translate several military terms into French. The usual French Military Term Book is pretty useless and does not give any of the words met with in *F.S.R.*

Read a French newspaper occasionally, and also read the French Training Manuals. This is most important and is essential. The object is to work up a *military vocabulary*. Later on, when reading *F.S.R.*, etc., translate it straight off into French without writing it down.

Bibliography.—

(E R) French Dictionary, Larousse Élémentaire Illustré (7/6).
(E R) Hugo's French Simplified (6/-).
(E R) French and English Technical Military Terms.—*Deshumbert* (3/6).
(G R) Règlements sur le Service des Armées en Campagne 1916.—*Ministère de la Guerre*, Paris.
(E R) Règlement Provisoire de Manœuvre d'Infanterie. Première Partie, 1921.—*Ministère de la Guerre*, Paris.
(E R) Règlement Provisoire de Manœuvre d'Infanterie. Deuxième Partie, 1921.—*Ministère de la Guerre*, Paris.
(G) *Revue Militaire Française* (monthly, 3/6).
(G) Les Principes de Guerre.—*Foch.*
Chambers' French-English—English-French Dictionary.
(G R) Half Hours of French Translation.—*Mariette.**
(G R) Key to Ditto.—*Mariette.**

* Very advanced, but extremely useful.

9. Political Economy.

The writer did not take this subject, but the best way to treat it is to write notes on the principal subjects, after reading the books recommended. The subject is interesting, and does not require much reading, since practically every officer has a good working knowledge on which to base his preparation for the examination.

Bibliography.—

(E L) Political Economy.—*J. S. Mill.*
(E L) Principles of Economics.—*Marshall.*
(E L) Elements of Economics.—*Marshall.*
(E L) Manual of Political Economy.—*Henry Fawcett.*

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10. HISTORY OF EUROPE AND U.S.A. SINCE 1848. HISTORY OF BRITISH INDIA.

The writer did not take these subjects, so does not feel competent to tender advice to those working at them.

The general principles governing the work noted above will, however, always apply, the chief of which is to read a limited number of the best books and think out the problems involved.

Bibliography.—
Outline of Modern European History.—*Rogers.*
Select Treaties and Documents to illustrate development of Modern European States.
Modern Europe.—*Grant.*
The Development of European Nations, 1870–1900.—*Dr. Holland Rose.*
The United States in our own times, 1865–1920.—*Haworth.*
The United States from 1765.—*Channing.*
History of the United States.—*Elson.*
Sir Charles Lucas's Historical Geography, Vol. III (India), 2 parts.
History of India.—*Sir W. Hunter.*
Rise of British Dominions in India.—*Lyall.*
Montagu-Chelmsford Report.

11. MOVEMENTS BY ROAD, RAIL, CROSS-COUNTRY, WATER, AIR

The paper set this year shows a reversal of policy as regards this subject. Nearly all the questions bore upon Transportation problems in France, 1914-18.

If this type of question is to predominate in future, the subject becomes very easy, but it would not be safe to entirely neglect the syllabus. The best sources of information as regards the military side of this subject are the *R.U.S.I. Journal* and the *Journal of the Institute of Transport.* Kirkaldy & Evans' book gives practically everything about all the other questions. The subject is very interesting and an easy one to get hold of. It is further of considerable value in working for the obligatory subjects.

Bibliography.—
(E L) The History and Economics of Transport.—*Kirkaldy and Evans.*
(E R) Elements of Railway Economics.—*Acworth.*
(G L) Rivers, Canals and Traffic on Inland Waterways.—*Vernon Harcourt.*
(E R) *Journal of the R.U.S.I.* (quarterly).
(E R) *Journal of the Institute of Transport* (monthly)
(G R) *Aeronautical Journal* (monthly).
(E R) Report of Civil Committee of Aerial Transport (9d.).
(G R) Airships for Commerical purposes (3d.).
(E L) Seaways of Empire.—*Sargent.*
(G R) Lloyd's Calendar.

12. RECAPITULATION.

This consists chiefly in reading up notes and papers. During the last fortnight before the examination it is not worth while embarking

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upon fresh investigations which will take time. It is better to consolidate and fix in the memory the facts already noted. The whole programme of work may be compared with the operations of the photographer. He first takes a negative, then develops the plate and then fixes it. The groundwork and preliminary investigation of any branch of a subject corresponds to the taking of a negative. The student then thinks over the arguments and points, and *develops* them in his mind. He then *fixes* these arguments and points by reading them over and perhaps writing a paper on them. In the examination he produces the finished *print.*

13. The Examination.

So many mistakes are made in procedure during the examination that a few notes on it will not be out of place.

The War Office issue :—

(1) Report on previous examinations, giving the papers set and the examiners' remarks ;

(2) Notes on Staff College Entrance Examination, 1921.

Read both of these very carefully. (1) is essential during the whole course of preparation, but the student should *read, mark, learn and inwardly digest* (2).

14.

The question of a proper distribution of time in the examination is of vital importance. Allow 15 minutes per 100 marks, and *do not spend longer* than this on a question carrying low marks, *e.g.*, in " Training for War," 1st Paper, 1922, Question 1 is worth 100 marks, Question 2, 300 marks and Question 3, 250.

Some officers spent one hour on Question 1 and had no time to even begin Question 5, which was worth 150. In the Imperial Organization papers each question is worth the same marks—250 if four questions, and 200 if five. Therefore spend three-quarters of an hour on each question in the first case, and just over half-hour each in the second. *It is vital that this allocation of time be strictly adhered to.* The marks gained by titivating answers to one or two questions will not compensate for those lost through completely spoiling the answer to the last question in the paper.

15.

In " Training for War " papers first read the *whole* scheme through, *underline* the salient words, and write notes in pencil on the left-hand side of the page on the principal points of the scheme. Cut out all non-essential. Number the remainder in the order in which they will be taken. Never write out the *scheme* again, but fasten on to the points that matter, *i.e.*, the governing factors. Rapidity is essential. If you have done schemes *against time* there should

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be no difficulty. If the facts and factors are fixed in one's mind it does not take long to write them down. What is written down must be clear and concise.

16.

Organization and Administration papers and Imperial Organization papers give a choice of questions. Read the whole paper through first, then consider carefully what questions will be answered, and mark them. Tackle first those you know best, and think out carefully exactly what is meant by the question. Each question is an essay in itself. Write down on the left-hand side of the paper the points bearing on the subject, *i.e.*, headings of the answer. Leave room to insert other points thought of afterwards, cut out those not essential and number the remainder in the order in which they will be taken. Keep any strong argument for the last and make the conclusions convincing. Having decided how to deal with these questions, commence writing. In a half-hour question take ten minutes to consider it and do the above rough work and allow twenty minutes to write the answer. If there is time, read the answers over to correct spelling mistakes and punctuation errors.

17.

Finally, it is very important to bring into the examination room a complete equipment of writing materials, etc., so that no time may be lost when actually working the papers and so that clear sketches may be drawn. The following will be found useful :—

Field Service Pocket Book.
A fountain pen which one can write quickly with.
A red ink fountain pen (not essential).
Coloured chalks.
Pencil.
Rubber.
Map measurer (very useful).
Protractor.
Scales with miles and yards marked :—
(*a*) 1 inch to 1 mile ;
(*b*) 1/20000 ;
(*c*) 2 miles to 1 inch ;
(*d*) 1/100000.

These scales are most useful to get artillery ranges, frontages, etc., quickly off the map. They can be drawn on a piece of drawing-paper if the protractor does not give them. They save time in the examination.

Always draw sketches to a large scale, and indicate very clearly the exact location and units of all troops in questions necessitating the disposition of troops on the map.

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Major-General Sir R. S. Curtis, K.C.M.G., C.B., D.S.O., A.A.-General, R.E., 1. 4. 13 to 23. 2. 17.

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MEMOIRS.

THE LATE MAJOR-GENERAL SIR REGINALD S. CURTIS, K.C.M.G., C.B., D.S.O.

THE writer's first recollections of "Reggie" Curtis are as a young officer at Chatham, a sturdy, square, strong-faced young officer—a face wrinkled with smile and cheeriness—Curtis playing mediocre accompaniments on the piano to a noisy chorus on a guest-night, or chaffing his fellows with a dry humour always to the point.

Serving as a subaltern in the 1st Divisional Telegraph Battalion at Aldershot for two or three years in the eighties, he soon began to show himself as an officer whose strength of character, carefulness in detail and innate common sense, combined with good humour, would carry him far. His record of service amply fulfilled this promise.

In 1888 he left Aldershot for a short tour at Gibraltar. In 1889 he went to Egypt. Joining the Egyptian Army in '91, he saw his first fighting in the Soudan War of that year and was given the Medjidieh for his good work. After a spell of home service he was sent as Director of Telegraphs to the Ashanti Expeditionary Force (1895–96), and for the able way in which he carried out that duty was awarded a brevet majority. It was here that he contracted a fever which was the foundation of much ill-health in later years.

In 1899 he was selected for special duty under the Admiralty in the Falkland Islands. Two months after his return from this work he started for the South African War of 1899–1902 as A.D.C. to Sir Elliott Wood, the Chief Engineer to the Expeditionary Force, shortly afterwards becoming Assistant Director of Army Telegraphs, and acting for some time as Director.

In November, 1900, he joined the newly-raised South African Constabulary and rose to the very responsible post of Inspector-General in 1905, an appointment he relinquished in 1908 for a well-merited tour in England.

After one and a half years as C.R.E., Edinburgh, Curtis returned to his old home at Aldershot as O.C. Troops and Companies; some two years later the Army Signal School was formed and he was posted to it as commandant. Thence to the War Office in 1913 as A.A.G., R.E., where he stayed four years, two of which were war

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years. We went to war in 1914 with a strength in officers and other ranks of about 6,000 and finished with something like 300,000—figures which alone are sufficient indication of the organizing power required of the A.A.G., R.E., and of the hard work involved. We Sappers are wholly to be congratulated that in Curtis we had the right man at the right time—but the long hours at the desk during these two strenuous years proved too much for him, and, early in 1917, he was obliged to give in. After a few months' rest as Commanding the Garrison at Cromarty, he became Major-General of Administration, Aldershot Command, and here he remained until the end of the War. He retired in March, 1920, with nearly 37 years of distinguished service to his credit; of these he would probably have counted his years with the South African Constabulary, where he gained the confidence and affection of the whole force, as his happiest; the years at the War Office, away from the front, tied to his desk and fighting all the time against ill-health, as his worst.

The writer, visiting him at his home in Kent, found him a victim to a painful illness, but he showed himself still the smiling, chaffing "Reggie" Curtis of old days, full of brave humour, keen and interested in anything that his enfeebled body would allow him to do. He died at West Farleigh on January 11th of this year—a fine character in every respect.

G. M. H.

GENERAL-OBERST VON BESELER.

GENERAL-OBERST VON BESELER, who died on the 21st December, 1921, was one of the most distinguished officers of engineers in the German Army. He was one of the half-dozen officers whose names were mentioned as possible successors to Graf Schlieffen when the latter ceased to be Chief of the General Staff in 1905 and the ex Kaiser nominated Moltke; and, in his arm, he was only surpasse in his professional career by General von Mudra, who at the close of the war became an army commander. Very like General Sir Herbert Miles in appearance, he was always interested in officers of Royal Engineers who visited Germany before the war, and went out of his way to be courteous and obliging to them.

The following particulars of his career are taken mainly from *Technik und Wehrmacht*:—

Born in 1850, in 1868 he entered the Guard Pioneer Battalion. After passing through the Kriegsakademie he, as usual with engineer officers, served a year in command of a company of an infantry regiment, returning to that arm later to command a battalion for a short time. He held, among Staff appointments, that of Instructor at the Kriegsakademie and Chief of the Army Section of the War Ministry, and under Schlieffen, was one of the three Deputy Chiefs

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of the General Staff. In the years shortly before the war he was Chief of the Engineer and Pioneer Corps and Inspector-General of Fortresses, succeeding Field-Marshal von der Goltz in that post.

During the war he was in charge of the siege of Antwerp, commanded the III Reserve Corps (nearest the coast) at the first battle of Ypres, was in charge of the siege of Novo-Georgievsk, and then, until the collapse, was Governor-General of Poland.

J.E.E.

REVIEW.

LA GUERRE MONDIALE, 1914–18.

By LIEUT.-COLONEL H. CORDA (Librairie Chapelot, Paris. Price 25 *fr.*) THIS book of over 400 pages, with a portfolio of 85 plans, should be a useful book of reference to the student who wishes to refresh his memory on the military history of the various events of the Great War. Each incident is described clearly and in a few words, and may be understood by the help of its plan in the shortest possible time. The plans are excellent, and have been provided in lavish abundance. The chief defect of the book is that it has no index. It is also unfortunate that the author did not rewrite some of the earlier incidents, and especially the Battle of the Marne, but contented himself with publishing several pages of *Additifs*, which, though they give correct information on certain incidents, including the action of Lieut.-Colonel Hentsch, which have now been public property for some years, do not succeed in removing the false impression given in the text of the causes of the victory and of the credit due to certain units and unit commanders who participated in the great struggle. The author shows fairness in his references to the action of the allies and his praise of Lord Kitchener and of the British soldier is obviously sincere. He also shows grateful appreciation of the work of the British Navy.

SAPER Î INŻYNÎER WOJSKOWY.

THE *R.E. Journal* welcomes the appearance of this new Polish Engineer Journal. No. 3 of the 1st volume contains original articles on the following subjects :—Anti-Tank Warfare ; Permanent Fortification in the War (with special reference to the Verdun Forts) ; Calculation of Mine Charges ; A Reconnaissance of the German Lines between Roie and the Oise ; Fire-fighting Methods. There are several good maps.

F.E.G.S.

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NOTICES OF MAGAZINES.

MILITÄR WOCHENBLATT.

No. 35.—*Washington and the Submarine Question.*—Admiral von Grapow commences by giving a résumé of the results of the Washington Conference, which he summarizes as a gigantic bluff on the part of England and America to save themselves unproductive expenditure. What has been achieved in Washington is that the relative strength of the navies of the world are fixed at to-day's ratio in respect to ships of the line and battle cruisers, and are to remain unchanged for the next ten years. England, however, agrees to allowing America a navy equal to her own.

He describes the resolution respecting submarine warfare as an agreement come to in order to save the face of the Conference and one which in practice can never be carried out. According to it, submarines can only attack merchantmen when they do not stop at request. Other ships can only be sunk after the passengers and crew have been placed in safety.

He goes on to describe Britain's policy in arming her merchantmen for defence and in denying the enemy's right to declare a blockade in her territorial waters, whereby every captain of an armed merchantman can regard the stopping of his ship in such waters as an attack, giving him the right to shoot in self-defence, conditions under which even the best-equipped submarine is at a great disadvantage to the most ordinarily armed tramp.

He draws the conclusion from the second paragraph of the agreement that submarines may sink a merchantman and, from precedents established by Britain, that they cannot be expected to take on board the crews of their victims who may be found in the boats or swimming in the sea. The precedents quoted are the sinking of the L19 and various torpedo-boats in the North Sea; the *Scharnhorst* near the Falklands, and *Cap Trafalgar* near Trinidad, where it is alleged that the German crews were left to drown, an act unjustified by either tactical necessity or the weather conditions, and this notwithstanding the fact that in contradistinction to the submarine, ample accommodation for the beaten crews was available on board the victorious ships without sacrifice in offensive power.

He quotes further:—"Other ships may be sunk after the crew and passengers have been placed in safety." Does a ship's boat in the open sea comply with this requirement? How can a submarine take on board the passengers and crew of a steamer that has obediently heaved to? The first prize taken would so hamper the submarine as to preclude further operations.

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Under these regulations, England, he declares, would make submarine warfare impossible by placing on board such vessels numerous passengers, including preferably some " American citizens " whose duty it would be to embroil Germany with America, as was so successfully done in the last war.

Those not in sympathy with the views expressed are invited to study samples quoted for their benefit from the literature of France and England, written before any idea of the Conference was mooted, and, therefore, unbiassed, to wit :—the prize essay entitled " The Influence of the Submarine in Naval Warfare in the Future," published in the November, 1919, issue of the *Royal United Service Institution Journal*, and Captain Castex's well-known article in the *Revue Militaire* of January, 1920.

Admiral von Grapow concludes his article in declaring that unscrupulous England will ignore in the future, as she has done in the past, laws which stand in the way of her victory, for Lord Fisher was right when he declared :—" The essence of war is force ; moderation is folly."

Au 3ième bureau du 3ième G. Qu. G. by Major Laure.—This book is very favourably reviewed by General von Kuhl, who declared it to be a valuable contribution to military literature, and as being especially interesting as portraying the changes in tactics followed by the French during 1917 and 1918.

No. 36.—*Poland and her Neighbours.*—According to the *M.W.B.* the Poles are rapidly reducing their army to peace establishment. It dates the inception of the movement to the decision of the Supreme Council respecting Upper Silesia, which it declares is favourable to Poland.

The country is divided into ten commands, comprising 28 divisions, including five newly-formed. The latter were brought into existence by reducing by one the four Infantry regiments of a division, and reorganizing the other arms. The artillery of a division in peace-time is given as :—

1 Brigade Staff ;
1 light artillery regiment, subdivided in three groups, each group comprising three batteries, one group being armed with howitzers ;
1 heavy artillery group (to be increased in war-time to a regiment with two groups).

The centre of gravity of the Polish Army remains as before on the Western frontier.

A new conscription law proposes terms of service as under :—
2 years with the colours ;
18 years in the reserve ;
12 years in the Landsturm (home defence).

The air force is said to consist of four regiments organized in 25 sections, totalling 600 aeroplanes of French and Italian manufacture, and four battalions for airship service. The whole is concentrated on the Western frontier.

The artillery is armed with French guns.

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Communists have attempted to undermine the army, but so far without success.

The Navy consists of six torpedo-boats. The construction of the harbour of Edingen progresses. Coast defence armament consists of 21 cm. howitzer and 15 cm. guns.

Poland and Czecho-Slovakia have concluded political treaties, designed, it is stated, to overthrow Germany's former economic predominance.

Tension still continues to exist between Poland and Russia over the execution of the Treaty of Riga, but it is not expected to provoke war.

Military and Political Report from Switzerland.—The bad effects of the high value of the Swiss exchange on the economic life of Switzerland is portrayed; to this fact the prevailing unemployment is ascribed. On the other hand, the military spirit of the Swiss is favourably reported on. In all branches great keenness is evinced, which is voluntarily carried on beyond the period spent with the colours. The standard of shooting is said to have attained remarkable efficiency. The machine-pistol is suggested as likely to become the rival of the light machine-gun.

Alleged Espionage in Military Clubs.—Regimental and Officers' Clubs are warned to be on their guard against Entente officers, especially English, who are alleged to be endeavouring to attend meetings as guests for the purpose of espionage, and especially to obtain copies of their rules.

No. 37.—Nothing of fresh interest.

No. 38.—*Soviet Russia.*—" Von W " gives his account of the happenings from November, 1921, to February, 1922. As a result of demobilization the men under arms have been reduced to 1½ millions, including Navy, Police and Frontier Troops, of whom about one-half are fighting troops.

The law of conscription provides for service from 18 to 40 years of age, of which two years are with the colours.

Reorganization is still in progress. Many institutions appertaining to the old army are being reintroduced—much is being done to promote better conditions of service, especially as regards accommodation which is very bad. One-third of the officers are of the old régime.

Training of leaders is receiving more attention. Courses of instruction are being held. To be a member of the working or peasant class is no longer considered the only qualification necessary. Those who have taken part in the courses of instruction form their own detachments which are especially reliable from the political point of view.

The first class, numbering 60 to 70, has passed out of the Red Staff College after a course of instruction lasting three years.

The first big manœuvres took place in the district of Kiev. One side consisted of 24 battalions, six squadrons and six batteries. He reports the scheme of the higher command as being well thought out and well executed. The capacity for work of the rank and file is described as satisfactory, but the execution was faulty in detail. Arrangements for reinforcements were totally lacking.

The famine is stated to be increasing. According to Nansen, 19 million inhabitants are directly threatened with starvation, of whom

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15 millions cannot now be saved. The Soviet Republic is not in immediate danger, as there has been no revolt as a result of the famine.

The Ninth Congress of the Councils sat in December and confirmed their programme, which included :—Safeguarding the peasant for a long term of years in the use of the land which is his " provisional " property, fixing the value of the rouble, cessation of the issue of paper money, safeguarding personal property.

The foreign policy favours the conclusion of economic treaties with the border states, with the idea of preventing their employment for intervention by Europe.

Russia's efforts to obtain recognition by the Powers are described.

Von W. thinks that her salvation should lie in aiding agriculture so as to increase production. The coming harvest, under the most favourable conditions, will yield less than last year.

Trade and finance are reported on as having recommenced, especially with Germany. Many fetters of the Communistic creed have been loosened ; the practice in banking, for instance, is said to be no different to that in vogue in capitalistic countries. The rouble continues to fall.

Notes on Tactical Leadership in the War, by Julius Frontinus.—The writer points out the efforts made during the late war to keep tactics up-to-date, together with the obvious difficulty of doing so with subordinate leaders continually decreasing in efficiency. Encounters generally developed very differently to that foreseen in the revised instructions. This, for reasons easily understood, was never brought out sufficiently clearly in the reports. Where a success was obtained, the battalion commander and the lieutenant were content to let their superiors believe that it was done according to the newly-prescribed procedure. The latter indulged in an optimism, which increased as the square of the distance from front line, as to the value of their new instructions.

Written instructions of this nature, rather than the rarer documents from front line, are always a principal source of information for military history, which, in consequence, unconsciously succumbs to such deception. Behind the front line the relation between cause and effect becomes more obscure.

Frontinus does not like the elastic defence, the training effect of which he especially deplores and which requires, in order to be effective, first class troops.

In his opinion, the ideal in war still remains to get the will of the commander conveyed without distortion right down through the chain of command to the fighter in the front line. This, he declares, is more important than the practising of the latest procedure, which is certain to be out of date very shortly. It is not essential that the operation should be " right " according to the latest text-book. The main object is to make the soldier an instrument capable of working with precision according to the will of his leader. Not, however, mechanically like a pianola, but able to attune himself to the necessities of every case. This adaptability is less a quality required of the private soldier than of the junior officer. The man who is always seeking as a guide for every situation a precedent in the histories of former wars, or whose orders are

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solely inspired by back files, is no leader, but rather he who is resolute and possessed of the ability relentlessly to convert his own decision into deeds.

Reviews.—The following are among the books that receive favourable notice :—

Kurzer Strategischer Überlick über den Weltkrieg 1914–18, by GENERAL-LIEUTENANT A. D. OTTO V. MOSER.

Der Gaskampf und die Gasschutzgeräte im Weltkrieg 1914–18, by OBERBERGRAT ING. G. RYBA.

H. DE C. TOOGOOD, *Captain, R.E.*

REVUE MILITAIRE GÉNÉRALE.

January, 1922.

The Cavalry We Require.—By General Robillot. This article enumerates the duties of cavalry, and enters a strong plea for its retention or even augmentation in the French Army, for such duties cannot effectively be performed by any other arm, or combination of arms, at present existing. On several occasions the Germans, owing to lack of cavalry, failed to develop successes they had gained. Consideration is given to the establishment required, to organization, equipment and training.

The Revision of the Regulations.—A continuation of the article by "Lucius," embracing the 5th period, or the latter half of 1917, which was marked by a radical change of procedure. Before the Battle of the Aisne it had been generally accepted that victory in the field could alone put an end to the War, and that economic, financial and political difficulties would not suffice. Till that time a rupture of the enemy's front was aimed at ; now the offensive was again confined to "limited objectives." When General Pétain assumed command of the French Armies, the country regarded the pause on the Aisne as a check, and, these misgivings spreading to the Army, the *poilu* had come to think that the sacrifices he had made were rated too cheaply, and signs of mutiny appeared in certain units which were met with tact and firmness by the C.-in-C. Secondly, further checks had to be avoided and the available reserves of men and material, though superior to those of the enemy, in view of the defection of Russia were estimated as insufficient to force a decision until early in 1918 when the assistance of the United States could be counted upon. For these considerations it was decided to wear down the enemy's forces, to hinder any aggression on his part, and to keep him in a state of nervousness by local attacks, which would at the same time raise the morale and confidence of the French troops.

Such were the principles enunciated by the C.-in-C. and developed later in the Instruction of 31st October and 20th December, 1917. The costly attacks deep into the enemy's position were to be replaced by attacks on limited objectives on as wide fronts as possible, prepared for in every detail, supported by a maximum of artillery to economize the infantry, and making use of surprise, which meant the organization of

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almost the whole front for offensive operations. It was laid down that little or no change of position was to be made by the guns, but that capture of the enemy's guns was always to be reckoned as a possibility, that field works undertaken must be so constructed as to alter the aspect of the field of battle as little as possible, that the attainment of surprise must not be endangered by a prolonged artillery preparation, for the numbers of large-bore Q.F. guns now admitted of ranging being carried out simultaneously with the installation of the batteries, and gas-shell could be used to neutralize the enemy's artillery, especially during the execution of the attack. The commander must order the advance of the infantry as soon as he was satisfied that the artillery had caused sufficient damage, although absolute destruction of the enemy's works had not been obtained. Defensive organization must ensure reinforcing with order and method in a minimum of time, by both artillery and infantry, any sector threatened or attacked, and also that formations were ready where required for counter-attack or relief. Railways and motor vehicles would play an important part in these arrangements, and besides a transport plan, a retreat plan should be prepared with the object of determining by how few effectives unthreatened sectors could be held. The possibility of a voluntary retirement of the enemy must not be lost sight of, necessitating a pursuit plan. To meet these various situations each army could, leaving aside periods of crisis, count on a fixed proportion of the troops available, as decided by the General-in-Chief, and to be understood to include reliefs for instruction and rest.

Special executive rules had been issued by the C.-in-C. on 20th June, 1917; with limited objectives infantry has no longer to advance beyond the zone bombarded by its artillery, and the question of halts to enable the guns to change position does not arise. Method can be exercised without hindrance as in siege warfare, risks and the unforeseen are eliminated, and continuity and rapidity in the attack recede to the background. Surprise is of the highest importance, and is facilitated by rapidity in the final arrangements, in the installation of batteries and in the artillery preparation. The rules, reflecting the spirit of organization and method, dealt with the offensive and defensive organization of the front, its division into sectors, the distribution of men and materials between the larger commands, the employment of the troops in line and in reserve, the necessity for considered forecasts of procedure in case of attack or defence, the well-being of the troops, the importance of instruction and discipline, and banishing any necessity for improvisation were a great advance on any hitherto promulgated. The rules were *secret* in that they were only issued to the higher commanders, but the guiding principle of them was unfortunately divulged during July by the Minister for War in the Chamber, and so brought to the knowledge of the troops and this may have had some effect in raising the waning morale of the enemy. Attacks on limited objectives were, however, only a temporary expedient to be renounced directly the period of equilibrium should be altered.

An amendment issued 27th July, 1917, modified to some extent the Instruction of 27th December, 1916. (1) The lesson drawn from the Battle of the Somme, advising a broad conception of operations, was

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omitted; (2) it was left an open question whether attacks should be strictly limited to wearing down the enemy, or should also aim at rupture "if the general situation permitted of such a result being obtainable," and the original chapter on the development of the success was re-published; (3) the battle for rupture was conceived of as a series of attacks following each other rapidly, and each prepared for by the previous assembly of every possible resource, especially a powerful artillery. Each successive objective was, therefore, to be determined in accordance with the radius of action of the guns without change of position, its capture then entailed a halt until the batteries could as rapidly as possible take up their new positions; (4) nothing was to be attempted by infantry unless it was sure of artillery support. New points in the Amendment were:—(1) manœuvres were to be based (*a*) on a profound study of the enemy's organizations and resources; (*b*) on surprise, and (*c*) on the peculiarities of the ground which might necessitate certain sectors being taken before others were attacked. (2) The front of attack was not only to be as wide as possible, but must be proportionate to the force available, and the depth of the thrust must be decided not only by the effective range of the guns, but by the limited capacity for penetration of the infantry; *e.g.*, the average front of a battalion would be 300 to 400 metres and its penetration 500 to 1,000 metres, making the battle front of a division 1,000 to 1,200 metres.

The Offensives of the end of 1917.—Outlines are given of the operations for the reduction of the Messines salient (7th June), in Flanders (31st July), North of Verdun (20th August), Malmaison (23rd October), and Cambrai (20th November). All were successful, some extremely so, and fulfilled the object of inflicting on the enemy greater loss than was sustained by the attackers, while the morale and confidence of the latter were enhanced. All presented similar characteristics—(*a*) the ascendancy of system; everything was pre-arranged with mathematical precision from which no departure was made; (*b*) the incessant augmentation of material resources, artillery, aviation, and tanks; (*c*) prolonged artillery preparation in order to husband infantry, but, except at Malmaison, neutralization of the enemy's batteries was not attempted prior to the infantry attack; (*d*) complete absence of surprise except at Cambrai, in spite of the C.-in-C.'s instructions; (*e*) attacks facilitated owing to there being no change of position of the guns during the action. As a result, each battle followed a mechanical plan, and development of the success was neglected, since it was impossible to forecast at what time and place it might occur. In conclusion, it may be said that the problem of wearing down the enemy was a nice one. To attain it, it is necessary to aim at the capture of one complete defensive system, and to drive the enemy back to another as far to his rear as possible. By this means only can the situation be cleared up, and time obtained for the victor to consolidate his gains without being subject to the continual annoyance which would occur if the enemy remained in too close proximity.

The French Cavalry During the First Three Months of the War.—By Colonel Monsenergue. This article does not pretend to give a detailed history of the operations of each of the ten cavalry divisions.

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Personal reminiscences, which alone have been published hitherto, give little or no idea of the influence of the cavalry operations as a whole on the conduct of the war, and the writer proposes to take a wider view. Chapter I gives a general sketch of the screening operations during the concentration of the French armies, Chapter II deals with General Sordet's 1st Cavalry Corps in Belgium from 8th to 23rd August, 1914. A map is attached showing diagrammatically the German concentration in Luxemburg and Belgium.

(*To be continued.*)

A. R. REYNOLDS, *Colonel.*

REVUE MILITAIRE SUISSE.

No. 2.—*February*, 1922.

Article 18 of the Swiss Constitution.—The original article is contributed by M. Agénor Krafft, who discusses therein the rights of the Swiss citizen under the provisions of Art. 18 of the Swiss Constitution of 1874, which runs: "*Tout Suisse est tenu au service militaire.*" It was in Art. 1 of the general military regulations of August 20th, 1817, that the statement was made that every Swiss *is* a soldier. In order to keep within the Vote for the Swiss Army, it has recently been necessary to cut down the numbers in the annual contingents called to the colours. The Swiss Government, in their difficulty, caused a reduction to be made in the numbers of the calling-up notices by bringing about a large proportion of rejections on medical grounds: M. Krafft questions the legality of the procedure adopted. He is of opinion that it is mischievous for the Government to direct the medical authorities, on some vague pretext, to certify that a young man who, in normal circumstances, would have received his calling-up notice is disqualified for military service.

Search for a New Discipline.—Captain Cingria's article on this subject, begun in the number of the *Revue* for November, 1921, is continued. In this part of his article Captain Cingria quotes various articles of the Swiss Regulations and comments upon them. His view appears to be that many of the words of command, and the custom and procedure in connection with the duties of guards and sentries, are archaic and require to be remodelled so as to be brought more in consonance with modern thought on social relationships between the various classes of the community. He is of opinion that as much latitude should be allowed in matters relating to sentry duty as are permitted in connection with the manner and method in which Town Police perform their duties. (*To be continued.*)

Disarmament?—Colonel Knapp, Commandant, 22nd Inf. Bde., the author of the original article, calls attention to a contribution to the *Journal Militaire Suisse* by Colonel Sarasin, who makes a pressing demand for disarmament and a reduction in military expenditure. Colonel Knapp points to the several economies which have been effected

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in recent times in the Swiss Army; he considers it rank hypocrisy for the people of Switzerland to raise the cry of poverty as an excuse for cutting down expenditure on national defence, so long as they can afford to spend a milliard (£40,000,000 at par) a year on luxuries, such as alcohol and tobacco for instance. He agrees, however, that it is up to soldiers to assist in a reorganization of the Swiss Army with a view to a reduction in the cost of its upkeep to the greatest extent possible.

NOTES AND NEWS.—*Switzerland.*—A comparative statement showing the expenditure on the several items of the Army Budget of 1920 and the amounts taken up in the Budgets for 1921 and for 1922 for these items is published in the Notes. In the case of the majority of the items the Budget provisions for 1921 and for 1922 differ but little from the expenditure in 1920; however, the sums taken up in the Budgets for 1921 and for 1922 for training are double the expenditure incurred under this head in 1920, whilst the amount provided in the Budget for 1922 in respect of contributions to military societies is quintuple the expenditure on this item in 1920. The Budget for 1922 makes up for an expenditure of 81 million francs as compared with an actual expenditure of 60 million francs in 1920.

France.—A special correspondent deals with the French Budget for 1922: the establishment of the French Army for the year in question has been fixed at 701,726 all ranks, involving a reduction of 50,000 all ranks in the establishment, as compared with the previous year. The establishment has been calculated upon the following basis:—

A.—Chargeable to the ordinary Budget.	*Men.*
Home Service	398,917
Algeria, Tunis and China	63,533
Morocco	85,951
Occupation Corps, Constantinople	6,926
Levant	50,000
Missions (extraordinary)	450
Sarre	7,765
B.—Expenditure which is recoverable.	
Rhine Provinces	86,959
Plebiscite regions	760
Commission on Control duty	465
Grand Total ...	701,726

In the Budget for 1921 provision was made for an establishment of 38,549 officers; this number is reduced in the current Budget to 35,953. In theory, service with the colours is now two years, but, in practice, in order that the expenditure shall not exceed the sums voted, a large number of men are given long leave. Apparently in no country can the civilian element resist the temptation to interfere in the military domain; complaints are rife that such interference is increasing in France.

W. A. J. O'MEARA.

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REVUE DU GÉNIE MILITAIRE.

December, 1921.

The first article by Colonel Audouard is a study of turning problems considering a train of vehicles drawn by a lorry and a description of a type of vehicle giving correct turning.

This article goes very fully into the question and the various conditions necessary to obtain correct turning are discussed. A type of vehicle is thus evolved which has been tried and given satisfactory results in actual practice, and which has been adopted for certain tractor-drawn bridging vehicles to carry long loads.

Some words on the Fortress of Metz by Commandant Tricaud.—The author gives a historical sketch of the Fortress, and briefly mentions the work done by Clovis about 480, the construction of an enceinte in 1444, the work done by the Duc de Guise in 1552, the construction of the Citadel in 1562, minor improvements by Vauban, the construction by Cormontaigne of the fortifications of Belle-Croix to cover the artillery acting towards Saint-Julien, and the fortifications of the three fronts on the Moselle facing towards the Northern slopes of Saint-Quentin. Some years before 1870 the French decided to abandon many of the forts along the frontier and to improve and retain only a few, including Metz, Langres, and Belfort. There were two schools of thought, the one that these fortresses should be large defended localities to give an army a favourable battle-ground, and the other that they should be bridge-heads to give an army room for manœuvre in front of an obstacle.

Marshal Niel's ideas were followed in the reorganization of Metz. He was much impressed with the power of artillery, and decided that certain well-chosen localities around Metz should be provided with forts of massive construction, having deep and wide ditches, and a powerful artillery.

He placed these forts on the near edge of the plateaux around Metz, so that, with their high command, they dominated the plateaux and yet were very little visible from the enemy's artillery positions and obser vation posts.

On these lines were built the forts of Queuleu, Saint-Quentin, Plappeville; with the exception of Saint-Quentin, where space was not available, they were all of large area. Later it was decided to construct intermediate forts, but in 1870 the possession of the Fortress passed to the Germans.

Up to 1900 the Germans contented themselves with building the forts planned by the French, and then adding a profusion of shelters, small forts, armoured and earth battery emplacements.

On the introduction of high-explosive shell they merely added one metre of concrete to their defences. There is no doubt but that the French Artillery could have breached these works very quickly.

About 1900 the Germans decided on a new form of defence and began the creation of *feste* on the more threatened sectors.

These *feste* are analogous in their rôle to the forts built by Marshal Niel: they consisted of an arrangement to safeguard from assault a certain number of turrets for heavy-calibre guns. These guns were

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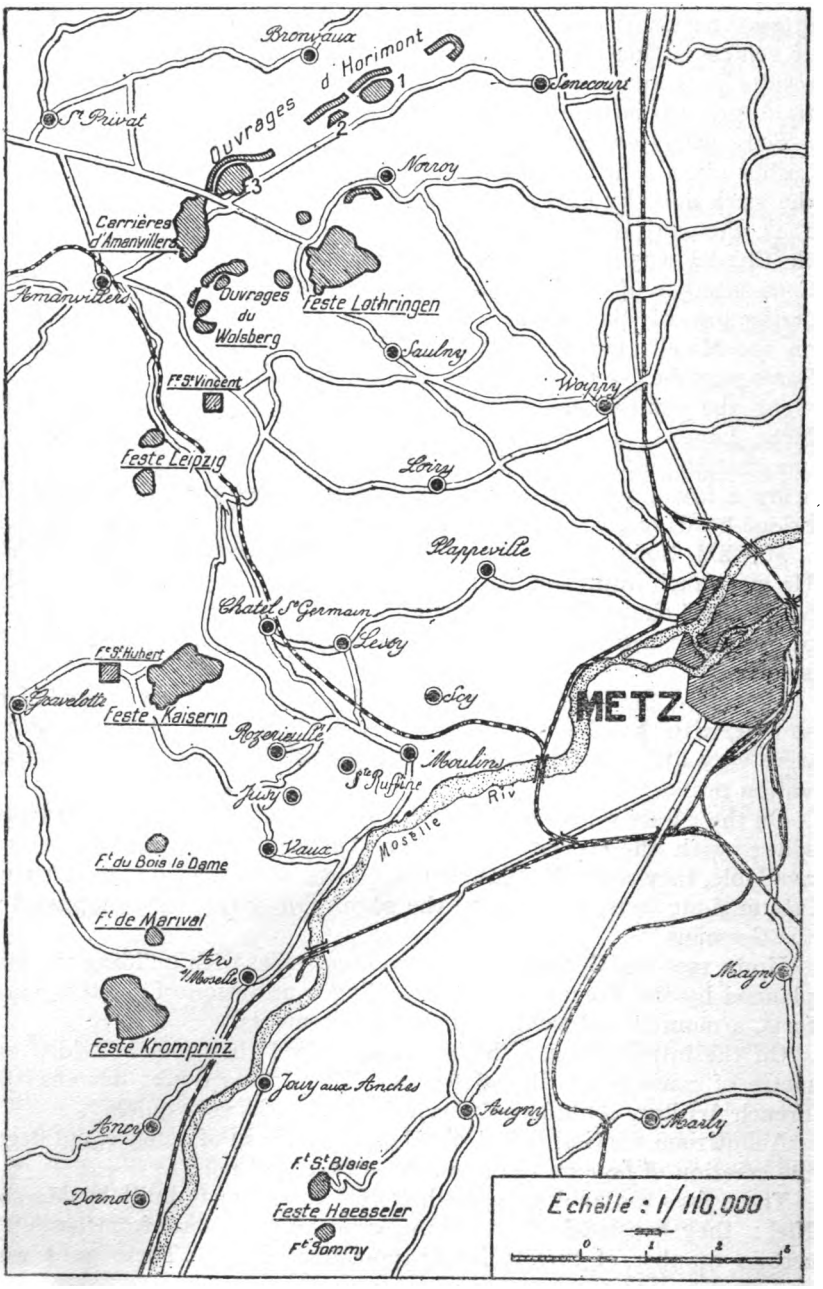
intended to keep the enemy at a distance and to prevent his advance. The most perfect of these *feste* is *Kaiserin*, which includes 12 heavy gun turrets in four batteries, protected in front by a ditch and elsewhere by a continuous trench behind a wire obstacle.

The ditch is flanked by an infantry work provided with field guns in



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casemates. The wire obstacle is swept from counterscarp positions, from casemates and from caponiers.

The author criticizes the visibility of the forts and the technical faults in their construction.

About 1908 the Germans, having realized the weaknesses of their *feste*, began to provide for close defence and for the flanking of the intervals. This was done with great skill, the method varying according to the ground. An example is given of the work done on the North-West sector of the defence from Horimont to Kronprinz.

(*a*) Horimont, a narrow, long, undulating spur, very steep on the enemy's side. The undulations would give dead ground from *feste* at either extremity. The Germans constructed a continuous ditch on the enemy side of the crest and, at intervals, placed a two-storeyed casemate in the ditch, the lower storey to fire along the ditch and the top one to provide fire over the ground in front. Behind the ditch are a very large number of shelters, trenches, O.P.'s, magazines, machine-gun and gun emplacements so scattered and concealed that it is difficult to imagine an artillery bombardment being very effective.

(*b*) Between Horimont and Leipzig two very interesting areas are found—the quarries of Amanvillers and Wolsberg. The former is fortified to defend the interval between Horimont and Wolsberg. The works consist of a group of trenches liberally supplied with mined dug-outs, and surrounded by a ditch cut in the solid rock defended from counterscarp chambers.

(*c*) The interest of Wolsberg lies in the fact that it is a field position carried out with all the resources of the art of engineering. It is a position for two battalions, each having its rest barracks provided with everything necessary to live under a prolonged bombardment. In front of the barrack is a support line with dug-outs in the trench itself or immediately adjacent to it. In front again is the front line provided with numerous shelters, O.P.'s, listening posts, machine-gun emplacements, emplacements for portable guns, in addition to the O.P.'s for the guns in the *feste Lothringen*, which has little field of view.

West of the position four heavy guns are sited to give flanking fire towards Saint-Hubert and Bois la Dame. In prolongation of this line a position for one battalion has been constructed on similar lines at the farm of Saint-Vincent.

The reason of the above system of defence is that the ground is very flat and under observation everywhere, and consequently, protection from artillery fire has been sought in dispersion.

(*d*) The plateau, including the *Feste Leipzig* and *Kaiserin* has not been fortified since 1908, presumably because the Germans did not have time to fortify it in accordance with their subsequent principles.

(*e*) From *Feste Kaiserin* to the ravine of Ars-sur-Moselle extends a plateau open to the North and wooded to the South and West. All the wooded portion is full of heavy guns covered by a continuous trench behind a wire obstacle, flanked by numerous works. In the open portion this flanking is obtained from three extensive works, built of earth, but provided with concrete shelters scattered over a large area. In the wooded portion the flanking works are concentrated in posts

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provided with ditches and means for producing flanking fire. At Bois la Dame there is a kind of Bourges casemate on the right flank and an armoured machine-gun casemate on the left flank. Bois la Dame is also interesting in that it is exceptionally well concealed, growing trees being left standing in pockets in made ground.

The last of the posts of this position—Marival—still incomplete, possesses a Bourges casemate for flanking the approaches to *Kronprinz.*

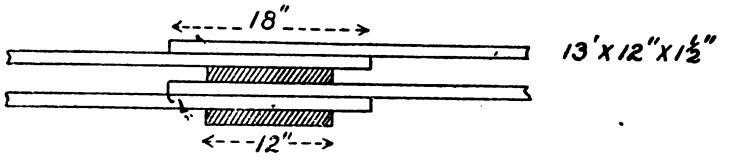
In conclusion, the author briefly shows how the method of defence has been made to conform with the ground all along the front and emphasizes that Metz offers a very interesting study to the military engineer since the study of the past permits the foreseeing of the future.

Assault Bridges of Floating Planks.—Colonel Thomas describes a type of assault bridge used with great success on several occasions in 1916, 1917 and 1918.

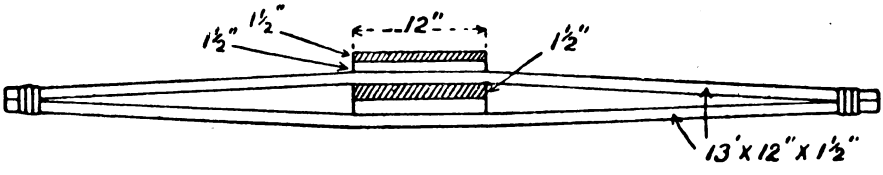
The bridge is described as being stable, light, easily constructed, hidden and carried. It is constructed of timber, approximately 13 ft. by 12 in. by 1½ in.

Bays are 11 ft. 6 in. from centre to centre of piers, which consist of single planks, or, if weaker timber is used, of two planks lashed together at their ends. The sketches below, which are sections along and across the bridge near a pier, show the method of construction.

The upper and lower planks of the roadway are either fastened together with ordinary lashings or holes are bored to take the lashings through the planks in the overlap, avoiding the cross timbers.



Section along Bridge.



Section across Bridge.

These bridges are suitable for lengths up to 150 to 160 ft. in a slow current and have been used up to 380 ft. where the current is negligible.

Experience as to suitable lengths for different currents is required.

C. TURNER JONES, *Captain, R.E.*

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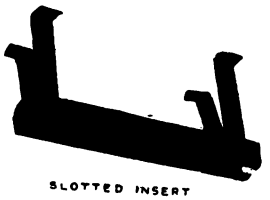

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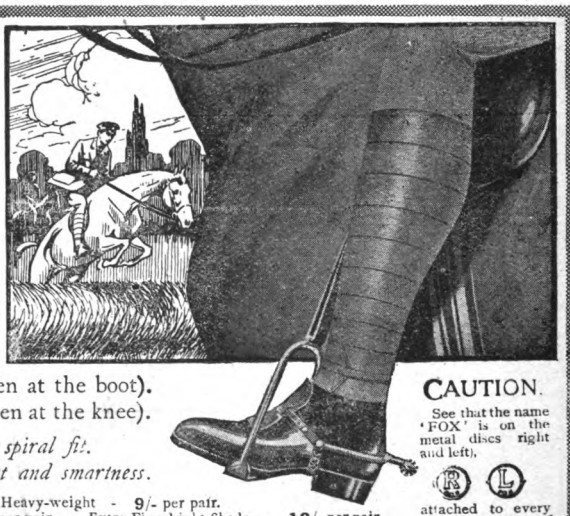

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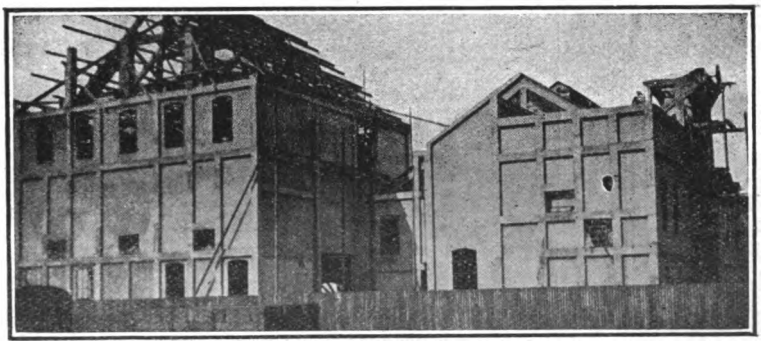

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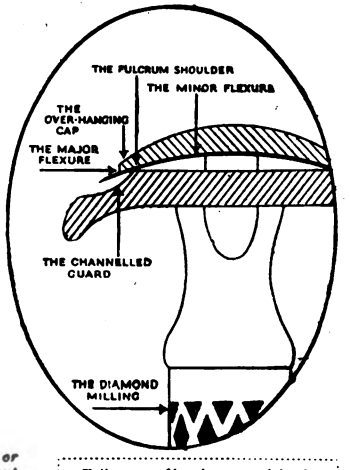

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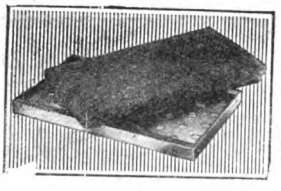

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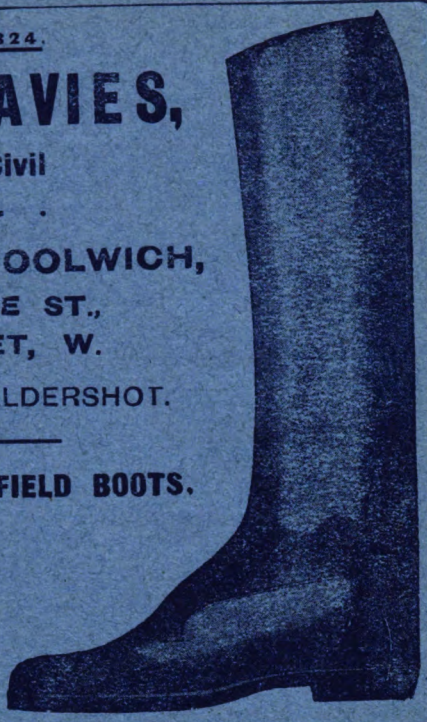

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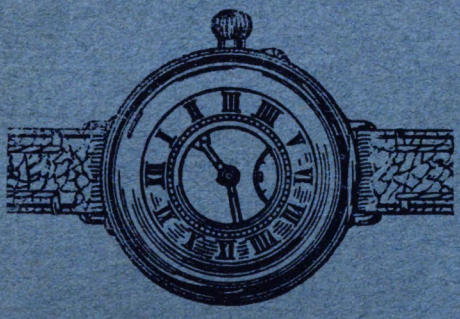

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